DEVELOPMENT AND VALIDATION OF A STROKE LITERACY ASSESSMENT TEST FOR COMMUNITY HEALTH WORKERS

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ABSTRACT

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Stroke is the fifth leading cause of death in the United States. Minority groups are disproportionately affected, particularly African Americans, who are three times more likely to be affected than their White counterparts. An effective strategy for addressing these disparities is to improve knowledge of stroke risk factors through innovative and culturally tailored education programs delivered by community health workers (CHW), such as the Columbia Institute for Training Outreach and Community Health (InTOuCH) program. The purpose of this study was to develop and validate outcome measures generated by the Stroke Literacy Assessment Test (SLAT) designed for use with community health workers (CHW) in a stroke prevention training program. The specific aims were to: 1) identify gaps in the literature related to assessment measures in stroke literacy for CHWs, 2) assess and evaluate the need for a stroke literacy assessment test for CHWs, 3) demonstrate evidence of the validity and reliability for the stroke literacy assessment test, and 4) assess stroke literacy in a sample of CHWs participating in the Columbia InTOuCH stroke prevention training program. The scoping review of literature demonstrated that CHW–specific competency assessment methods were limited, with few or no domain-referenced tools on stroke risk factors that complied with measurement standards. Guided by the CHW assessment context, the study applied a unified instrument design and

validation approach using an iterative Process Model to develop the SLAT. The SLAT content domain was first specified to produce an initial item pool. Both were content validated by external expert review and refined. Next, empirical validation continued with evidence on examinee response processes, diagnostic item statistics and quality, total score reliability and verification of theoretically expected subgroup differences in SLAT scores. The iterative design process yielded a subset of well-functioning items of the initial 46. These were assembled to construct a final assessment test for empirical evaluation. The final SLAT was administered to 68 CHW alumni of the InTOuCH training program. Results showed that a 34-item SLAT that assesses the *factual knowledge* and *application* levels of cognition demonstrates sufficient validity and reliability for use with CHWs specializing in stroke prevention efforts.

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JM

DEDICATION

To My Mum and Sister

CHAPTER I

INTRODUCTION

Cardiovascular diseases (CVDs) are a group of heart and blood vessel disorders that include heart disease and stroke. They are responsible for one in every three deaths in the United States, with stroke being the fifth leading cause of death (Bufalino et al., 2020).

Despite such trends in prevalence and mortality, 90% of all strokes remain preventable and can be attributed to MRFs (Hankey, 2020). The seven key MRFs in stroke prevention include high blood pressure (BP), high cholesterol, diabetes mellitus (DM), smoking, obesity, unhealthy diet, and physical inactivity (Diener & Hankey, 2020). The American Heart Association (2020) has recognized the modification of these seven MRFs as the goal to achieve ideal cardiovascular health (Virani et al., 2020). This chapter will discuss the epidemiology, disease burden, risk factors, and stroke prevention strategies in the United States, as well as the emerging role of CHWs in stroke prevention.

Epidemiology of Stroke

Stroke is the fifth leading cause of death in the United States, as well as the leading cause of long–term disability (Virani et al., 2020). A stroke occurs every 40 seconds on average in the United States, and one person dies every four minutes (Virani et al., 2020). Every year, an estimated 795,000 people in the United States suffer a stroke, with 77% experiencing their first–ever stroke event (Furie, 2020; Virani et al., 2020). Strokes can happen to anyone at any age. However, people over the age of 65 account for three–quarters of all strokes (MMWR).

Stroke prevalence has remained stable at 2.7 percent, with no significant change between 2006 and 2010. Although there was a 2.3 percent decrease in stroke mortality overall during this time period, it was not proportionate across all population subgroups (Furie, 2020). Even at younger ages, African–Americans continue to have higher stroke mortality rates than whites (Guzik & Bushnell, 2017).

Strokes can be broadly classified into two types: hemorrhagic and ischemic (Boehme et al., 2017). The majority of strokes (87%) are ischemic, and the number of deaths is expected to double by 2032 (Furie, 2020). Despite these alarming trends in prevalence and mortality, 90 percent of all strokes are still preventable and can be attributed to modifiable risk factors (Hankey, 2020).

Stroke Risk Factors

There are numerous risk factors for stroke, both modifiable and non–modifiable. Age, gender, race/ethnicity, and prior heart disease are non–modifiable risk factors. High blood pressure, high cholesterol, diabetes, smoking, obesity, an unhealthy diet, and physical inactivity are all modifiable risk factors. High blood pressure is the most common modifiable risk factor, accounting for one–third of all strokes (Diener & Hankey, 2020). These risk factors can be reduced or eliminated by lifestyle modifications to reduce the risk of stroke.

The American Heart Association's (AHA) strategic impact goal for 2020 was the next to improve the cardiovascular health of all Americans by 20%, while reducing CVD and stroke deaths by 20% (Virani et al., 2020). To that end, the AHA defined ideal cardiovascular health as the modification of seven risk factors known as the Life's Simple 7, which included four core health behaviors (smoking, physical activity [PA], diet, weight) and 3 health factors (blood pressure [BP], cholesterol, and glucose control) (Virani et al., 2020). The update also advocated for primary prevention through the reduction of these risk factors, as well as a continued emphasis on secondary prevention through treatment. These risk factors were identified by Goetzel et al. (2012) as seven of the top ten metrics that contribute to significant healthcare expenditure in the United States (Goetzel et al., 2012).

Stroke Prevention

Stroke prevention aims to reduce the occurrence of stroke by modifying specific risk factors at the individual, community, or population levels (Boehme et al., 2017). There are three broad levels of stroke prevention: 1) *primordial prevention*—taking action to prevent future health hazards by reducing the factors known to increase the risk of a disease; 2) *primary prevention*—improving the risk of an individual with no history of stroke, to prevent the onset of a first stroke event; and 3) *secondary prevention*— treatment of an individual who has had a stroke to prevent a recurrence (Boehme et al., 2017). Adopting healthy lifestyle behaviors such as healthy eating, regular physical activity, and quitting smoking are examples of primordial prevention. Primary and secondary stroke prevention focuses on specific lifestyle changes to prevent the onset of diabetes, hypertension, cholesterol, and obesity, among other things (Boehme et al., 2017; Weintraub et al., 2011).

The burden of stroke attributable to modifiable risk factors highlights the need for a "harmonious two–tiered approach" to prevention, which includes education about stroke risk factors and healthy lifestyle behaviors (Hankey, 2020). Research has shown that community–based stroke interventions delivered by adequately trained community health workers are highly effective in stroke risk factor education and management (Brownstein et al., 2005).

Although national guidelines aimed at reducing and preventing the rise in heart disease and stroke, little progress has been made in meeting these objectives (Healthy People, 2030). This is due to a lack of physician–patient time, non–aggressive treatment by physicians, patient barriers to self–management, and a lack of supportive skills and resources in non–communicable disease management (Brownstein et al., 2005).

The WHO guidelines for CVD and stroke prevention (2007) recommend a combination of population–wide and high–risk approaches (WHO, 2007). Population–based strategies are the most effective in stroke and CVD prevention because they target behavioral and lifestyle risk factors such as cigarette smoking, physical inactivity, poor diet, obesity, high blood pressure, elevated blood glucose, and cholesterol (also known as Life's Simple 7) (AHA, 2020). To that end, the World Health Organization (WHO, 2018) has recognized the importance of investing in community–based prevention measures, specifically CHW–led interventions, in order to combat this growing problem. Research has shown that community–based stroke interventions delivered by adequately trained community health workers (CHW) are highly effective in stroke risk factor education and management (Brownstein et al., 2005).

Community Health Workers in Stroke and Cardiovascular Disease Prevention

"A community health worker (CHW) is a frontline public health worker who is a trusted member of and/or has an unusually close understanding of the community served. This trusting relationship enables the CHW to serve as a liaison/link/intermediary between health/social services and the community to facilitate access to services and improve the quality and cultural competence of service delivery. A CHW also builds individual and community capacity by increasing health knowledge and self–sufficiency through a range of activities such as outreach, community education, informal counseling, social support, and advocacy" (APHA, 2010).

The roles and activities of CHWs vary greatly across programs. While some CHWs are trained to perform a wide range of tasks that can be preventive, curative, and/or developmental in nature, others are trained to focus on very specific interventions. In any case, CHWs are increasingly being equipped with a broad range of knowledge and skills to deal with a wide range of roles across the globe (Brooks et al., 2014; WHO, 2007).

The American Heart Association (AHA), like the WHO, recommends the use of Community Health Worker (CHW) interventions in the prevention of cardiovascular disease and stroke (AHA, 2018). Given the CHW model's unique ability to improve cultural competency and health literacy in disadvantaged communities, it has been actively pursued as an effective means of reducing heart disease and stroke disparities among these populations (Brownstein et al., 2005). In the United States, CHW–led stroke interventions in the United States have shown significant improvements in health literacy, risk factor control, self–management skills, lifestyle habits, and a decrease in inappropriate health care utilization (Towfighi et al., 2017). However, for interventions to be implemented successfully, CHWs must be prepared with solid initial training, valid competency assessments, ongoing monitoring, and continuing education (Kapheim & Campbell, 2014).

Problem Statement

Stroke is known to disproportionately affect minority populations in the United States, with a higher incidence and mortality in minority groups. These disparities are attributed to the different effects of risk factors on minority groups, such as high blood pressure, a lack of access to health care, ineffective risk factor control, and genetic predisposition to stroke risk factors. (Gutierrez & Williams, 2014). Specifically, African Americans with high blood pressure have three times the risk for stroke compared to their White counterparts for every 10mm Hg increase in systolic blood pressure (BP) (Howard et al., 2013). They also experience higher death rates, even at younger ages (Guzik & Bushnell, 2017). They also lack knowledge and awareness of stroke risk factors, and timely prevention methods putting them at twice the risk for having first–time strokes (Covington et al., 2010; Levine et al., 2020). Many also experience inequitable stroke prevention due to cultural and communication barriers, and other forms of structural inequity (Bufalino et al., 2020).

Community–based interventions that focus on changing individuals' behaviors are an effective method for reducing the population–level risk of disease (McLeroy et al., 2003). Specifically, culturally tailored and innovative community–based stroke interventions such as the Beauty Shop Stroke Education Project (Kleindorfer et al., 2008), the church–based SHARE (Stroke Health and Risk Education) trial (Zahuranec et al., 2008), the SUCCEED trial (Secondary Stroke Prevention by Uniting Community and Chronic Care Model Teams Early to

End Disparities) (Towfighi et al., 2017), and Hip Hop Stroke (Williams & Noble, 2008) are examples of evidence–based community education interventions that have shown to be effective in stroke literacy and stroke preparedness. These stroke–focused educational interventions show that innovative and culturally tailored programs can be extremely effective in addressing racial and ethnic disparities in stroke mortality (Levine et al., 2020). However, there is no valid and reliable test assessment of CHW knowledge and skills specific to stroke prevention.

Purpose of the Study

The purpose of this study was to develop and validate outcome measures generated by the Stroke Literacy Assessment Test (SLAT)—pertaining to the seven modifiable risk factors—designed for community health workers (CHW) in a stroke prevention training program.

Specific Aims

The specific aims of the study were to:

1. Identify gaps in the literature related to assessment measures in stroke literacy for community health workers.
2. Assess and evaluate the need for a stroke literacy assessment test for community health workers.
3. Demonstrate evidence of the validity and reliability for the stroke literacy assessment test.

4. Assess stroke literacy using the SLAT in a sample of CHWs in the InTOuCH stroke prevention training program.

Study Population and Setting

The literature has shown that an individual's health in New York City is frequently determined by a resident's ZIP code. As of 2019, Harlem, a neighborhood in New York City's Upper West Side of Manhattan was estimated to have a population of 136,351, with 54.3%identifying as Black, 23.6% identifying as Hispanic, 15.5% identifying as White, and 3.6% identifying as Asian. Central Harlem has a life expectancy of 75.1 years, while the Financial District had an expectancy of 85.4 years (NYT, 2017).

Central Harlem and East Harlem are also two of Manhattan's unhealthiest neighborhoods in almost every health category studied. According to the New York City Department of Health and Mental Hygiene's 2015 community health profiles, they have some of the highest rates of diabetes, cancer, and chronic diseases (NYCDOH, 2015).

A person's lifetime exposure to certain social, economic, and physical environments that dictate access to resources, influence individual behavior, and, in some cases, directly increase risk is linked to their risk of dying early from heart disease and stroke. Smoking, an unhealthy lifestyle, and high blood pressure, high cholesterol, diabetes, and obesity all increase the risk of these two conditions (New York City Health, Epi Data Brief).

Central Harlem is Manhattan's second poorest neighborhood, with 29% of residents living below the federal poverty line. Poverty limits healthy lifestyle options and makes access to health care and resources that promote health and prevent illness difficult. Furthermore, nearly one in every five adults lacks health insurance, and one in every nine does not receive necessary medical care. Central Harlem is also the city's fourth–highest rate of stroke hospitalizations and significant gaps in stroke literacy. As a result, there is an urgent need to improve stroke literacy in such high–risk communities through culturally relevant individual and community–based strategies (Willey et al., 2009).

Significance of the Study

The Columbia Institute for Training Outreach and Community Health (InTOuCH) is a community–based, stroke prevention program centered in Harlem, New York City. The faith–based community intervention model is used in this program to deliver stroke awareness and education to the community through CHWs.

The program's goal is to organize and train a team of CHWs from churches and community–based organizations who provide health screenings, counseling, and referrals to local community clinics and hospitals for medical follow–up. The eight–week training program is based on the CDC's CHW stroke prevention training curriculum, which includes six weeks of comprehensive didactics covering health topics such as stroke, heart attack, diabetes, high blood pressure, cholesterol levels, smoking cessation, health eating, physical activity, obesity, motivational interviewing, and navigating the New York State health insurance system. The instruction consists of 72 hours of didactic and hands–on practical skills instruction. The nature of the instruction, as well as the active learning experiences provided during the lectures, are based on all cognition levels (concepts, understanding, application, and complex procedural skills).

The remaining two weeks are devoted to skills training, which includes blood pressure (BP) measurements, BMI assessments, cholesterol and hemoglobin A1C (HbA1c) testing. The trainees' performance is evaluated through baseline and post–training knowledge tests and skill assessments. Through this training, CHWs will gain proficiency in blood pressure measurement techniques and acquire effective communication skills for stroke and CVD health counseling among other skills. The CDC curriculum assessment test is used to assess CHWs' knowledge of stroke prevention before and after training, and a validated assessment test is needed. To date, InTOuCH has trained 11 cohorts and 130 CHWs.

Theoretical Foundation

The conceptual framework for this study and the development of the instrument were based on two models: the *Process Model for Assessment Design, Validation, and Use* (Chatterji, 2003, pp. 104–110) and the *Functional Taxonomy* (Chatterji, 2003, pp. 139–140).

The Process Model for Assessment Design, Validation, and Use

The Process Model for Assessment Design, Validation, and Use developed by Chatterji (2003) specifies a cyclic process that includes planning (Phases I and II), instrument design or selection (Phase II), content validation of the instrument (Phase IVA), and empirical validation of the instrument (Phase IVB) (Chatterji, 2003) Figure 1.1.

Figure 1.3: A Process Model for Assessment Design, Validation, and Use

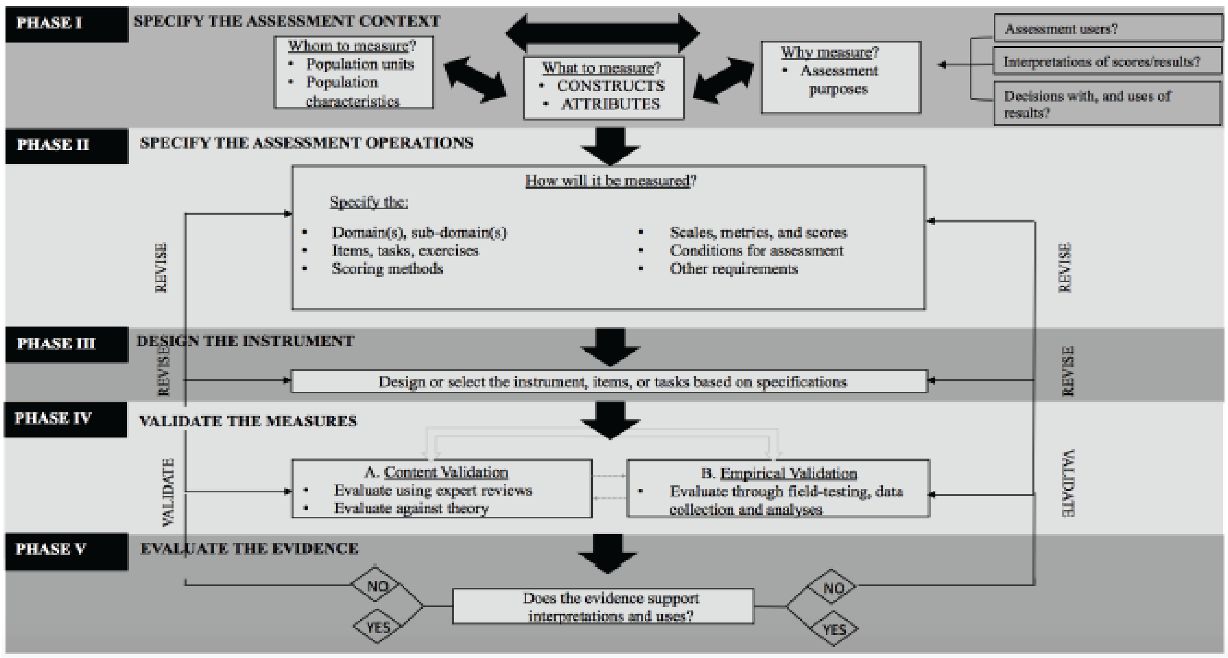

Figure 1.1. A Process Model for Assessment Design, Validation, and Use

In Phases I–II, assessment specifications for the intended tool are developed, and the assessment tool is linked to assessment specifications (in Phases III). Following validation (in Phase IV), the assessment tools are typically revised until a level of quality that meets the demands of the decision–making context is obtained. The tool is then ready to use. Validation is thus a quality–control procedure (Chatterji, 2003, p. 119).

Assessment specifications are essential planning tools that define the design parameters for the instruments and provide a blueprint for designing a written structured response test (W–SR). Such specifications guide the number of questions that would have to be written to measure particular learning outcomes for a construct domain.

The Process Model is an iterative and integrative model. The feedback loops in the Figure 1.1 show that we can repeat the design, validation, and revision cycle until we achieve the desired level of quality. It also provides a framework for connecting the user context with assessment design and validation work. This process helps the designer in considering the context of assessment design and evidence from validation studies before deploying an instrument (Chatterji, 2003, pp. 105–120).

Components of the Process Model include:

- Domain, construct domain, performance domain
- Assessment specification, table of specifications, test blueprint
- Content validation
- Empirical validation

Therefore, this model provides a framework for systematically considering the context of assessment designs and evidence from validation studies before putting a test to use.

Functional Taxonomy

Once the foundation plan is laid with the process model for assessment design and use, the next most important step is to define specific learning outcomes and categorize them according to taxonomic levels. This crucial step allows for a singular focus on a specific taxonomic levels and deliberately designing instructional and assessment strategies.

At the most general level, knowledge assessment tests are designed to evaluate “what the learner knows”. However, “knowing” is a complex achievement with many cognitive dimensions that can be assessed by applying taxonomies to learning outcomes. As defined by Chatterji (2003) “a learning taxonomy is a classification system that teachers and assessment developers use to analyze and obtain a deeper understanding of the types of behaviors or levels of cognitive complexity that will be targeted for assessments” (Chatterji, 2003). Ideally, a fair and useful evaluation of a student's abilities should assess how well a student can recall (knowledge) and understand learning material (comprehension), how well the student can use this information or skill in a new setting (application), how well a student can break down, differentiate or analyze material (analysis), and how well a student can compile, create (synthesis) information to provide judgments or criticism of the material (evaluation). These six categories represent *Bloom's Taxonomy of Educational Objectives* (Bloom et al., 1956). These progressive cognitive domains cumulatively build on each other, for example, for a student to perform at a higher cognitive level (such as application), they would have to incorporate all the lower taxonomic levels (i.e., knowledge and comprehension) (Bloom et al., 1956; Chatterji, 2003).

This study describes the development of a stroke literacy assessment test (SLAT) for community health workers aimed to tap into the lower levels of cognitive levels such as knowledge, comprehension, and application. To ground this work, the *Functional Taxonomy* developed by Chatterji (2003) was used to classify the indicators and learning outcomes to best fit the construct domain 'stroke literacy' (Chatterji, 2003, pp. 139–140) (Figure 1.2).

The Functional Taxonomy "recognizes four cognitive processing capacities, each requiring different types or levels of mental demands: concept recall and understanding is at the lowest level; application is at the next higher level; and complex procedural skills and higher order thinking and problem–solving skills are the two most demanding levels of cognitive processing" (Chatterji, in preparation/in press, pp. 28–29). These four categories are cumulative, therefore, for an application level task, concept knowledge and understanding will be used. Similarly, higher order thinking and problem–solving tasks will include both concept recall and understanding as well as application skills.

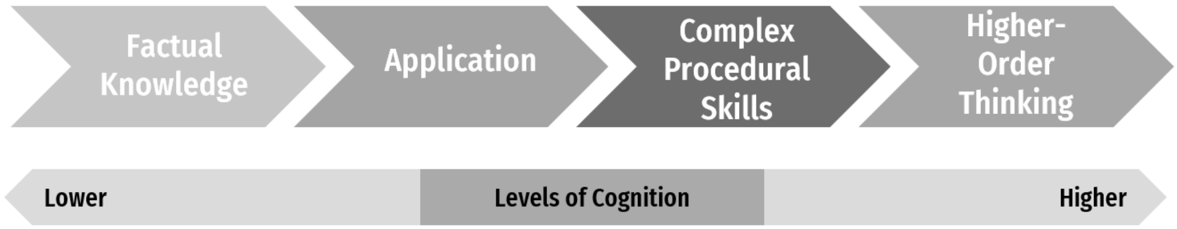

Figure 1.2. The Functional Taxonomy (adapted from Chatterji, 2003)

Unlike Bloom's taxonomy, the categories in the *Functional Taxonomy* are not dependent on each other and are intended to be stand–alone categories (Chatterji, 2003). In this study's context, a learning outcome classified at the application level will indicate that the assessment design will focus on application skills as defined in the *Functional Taxonomy.*

In the case of the SLAT, the general and specific learning indicators used the *Functional Taxonomy* to tap into lower levels of cognition (*factual knowledge, application*) for assessment of CHW knowledge in stroke literacy.

For example:

General indicator: 1.0 *Demonstrate knowledge of hypertension and how to prevent it*

Specific Indicators:

1.1.1 Demonstrate knowledge of blood pressure measurement *(Application)*

1.1.2 Interpret the meaning of systolic and diastolic pressure *(Factual Knowledge)*

Sample Question: Look at the blood pressure dial below and answer the following:

i) Look at the reading in this figure and record the blood pressure (1.1.1) (Application) *ii) The upper number is known as systolic pressure and lower number is known as diastolic pressure: True/False? (1.1.2) (Factual Knowledge)*

Therefore, allowing for designing the assessment test with clear categorization of the learning outcomes. Guided by the Functional Taxonomy, this initial iteration of the SLAT was designed in the W–SR format.

Definitions and Terms

Assessment: A purposeful and disciplined set of procedures (embodied in an instrument) aimed at describing, quantifying, and facilitating inferences about degrees to which particular characteristic(s) exist in given groups of persons, objects, events, organizations/ entities (Chatterji, 2003).

***Community Health Worker*:** A community health worker (CHW) is a frontline public health worker who is a trusted member of and/or has an unusually close understanding of the community served. This trusting relationship enables the CHW to serve as a liaison/link/intermediary between health/social services and the community to facilitate access to services and improve the quality and cultural competence of service delivery. A CHW also builds individual and community capacity by increasing health knowledge and self–sufficiency through a range of activities such as outreach, community education, informal counseling, social support, and advocacy" (APHA, 2010).

Evaluation: A judgement–based decision pertinent to whether a construct measure is "good" or "bad" for a given purpose (Chatterji, 2003).

Measurement: Measurement is a part of the assessment procedure—it is the "scale" or scaling component that yields the number or a numeral (Chatterji, 2003).

Stroke: A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is either blocked by a clot or bursts (or ruptures). When that happens, part of the brain cannot get the blood (and oxygen) it needs, so it and brain cells die (AHA, 2020).

Test: A "test" is one type of assessment tool (current consensus). Assessment is a broad term encompassing various types of instruments (Chatterji, 2003).

Researcher's Experience

As the program lead for Columbia University's Institute for Training Outreach and Community Health (InTOuCH) program, I have been involved in the inception of the program since 2016. This community–academic partnership program utilizes the knowledge and skills of the community and expertise of the university faculty to combat the stroke and cardiovascular disease (CVD) risk burden in communities of color. Using community–based participatory research (CBPR) approaches, I have engaged key leaders from community and faith–based organizations, recruited volunteers, designed culturally–relevant health curriculum, and facilitated didactics in stroke and CVD prevention. I have also trained CHWs in practical skills (BP, BMI, HbA1C), and developed evaluation measures for the program. My professional preparation and background as a physician and public health educator, and my experience in training community health workers in India (Birur et al., 2013; Mallaiah, 2013) and the United States (Mallaiah et al., 2018; Colville et al., 2020), has given me first–hand knowledge on training and evaluation methods for CHW training programs. This experience has given me an understanding of the urgent need for standardized training methods and evaluation metrics to assess CHW readiness for field work. In addition, my previous work as a clinician and project coordinator for the Hip Hop Stroke program (Tshiswaka et al., 2018; Williams et al., 2018) will inform my work on the design and validation of this stroke–focused assessment test—including domain specification, construct definition, item construction, and validation methods.

Use of Human Subjects and Ethical Considerations

This research study will be conducted in compliance with the Institutional Review Board of Teachers College, Columbia University. A research protocol and written consent form was developed for participants. The informed consent provided details of the research aims, risks, benefits, data privacy and confidentiality procedures. All participating CHWs were assigned a unique identifier separated from names or any other information that can identify participants. The research files that link names and identifiers were saved on a password–protected computer, and only the investigator had access to the file. All study data have been stored in encrypted files in a secure location to protect confidentiality.

Conclusion

This chapter has provided an overview of the stroke risk burden in the United States, especially in African American populations. One solution with which to address the disproportionate burden of stroke in this community is the implementation of innovative community–based programs—such as the InTOuCH program that utilizes CHWs. It also presented the significance, and rationale for development of a valid and reliable instrument to assess knowledge, and skills of CHWs in a stroke prevention program using the *process model for assessment design, validation, and use* and *functional taxonomy*.

CHAPTER II

A Scoping Review of Stroke–Focused Competency Assessment Tools for Community Health Workers in the United States

Introduction

Stroke is a major contributor to chronic disease burden in the United States (CDC, 2021). Nearly 4% of US adults will have had a stroke by 2030, accounting for increasing medical costs from $71.55 billion in 2012 to $183.13 billion by 2030 (Ovbiagele et al., 2013). Its prevalence remained at 2.7%, without significant change between 2006 and 2010. Although an overall 2.3% decline in stroke mortality took place during this period, it was not proportionate across populations (Furie, 2020). Specifically, stroke death rates continue to be higher for African Americans compared to whites, even at younger ages (Guzik & Bushnell, 2017). Many also experience inequitable stroke prevention due to cultural and communication barriers, and other forms of structural inequity (Bufalino et al., 2020).

Despite such trends in prevalence and mortality, 90% of all strokes remain preventable and can be attributed to modifiable risk factors (MRF) (Hankey, 2020). The seven key MRFs in stroke prevention include: high blood pressure (BP), high cholesterol, diabetes mellitus (DM), smoking, obesity, unhealthy diet, and physical inactivity (Diener & Hankey, 2020). The American Heart Association (2020), has recognized the modification of these seven MRFs as the goal to achieve ideal cardiovascular health (Virani et al., 2020).

Stroke prevention aims to target risk factor modification at an individual, community, or population level (Boehme et al., 2017). Primordial prevention includes adoption of healthy lifestyle behaviors like healthy eating, regular PA, and abstaining from smoking. Primary and secondary prevention of stroke is targeted towards specific lifestyle modifications to prevent onset of diabetes, hypertension, cholesterol, and obesity (Boehme et al., 2017; Weintraub et al., 2011). The burden of stroke attributable to MRFs underscores the need for a “harmonious two–tiered approach” to prevention: education about stroke risk factors and adoption of healthy lifestyle behaviors (Hankey, 2020).

Although national guidelines aimed to reduce and prevent the rise of heart disease and stroke, little progress has been made in achieving these goals (Healthy People, 2030; Heisler et al., 2016). This is attributed to limited physician–patient time, non–aggressive treatment by physicians, patient barriers to self–management, and lack of supportive skills and resources in management of non–communicable diseases (Brownstein et al., 2005). The World Health Organization (WHO, 2018) has recognized the importance of devoting resources in community–based prevention measures—namely CHW–led interventions to tackle this growing problem (WHO, 2018). Research has shown that community–based stroke interventions delivered by adequately trained community health workers (CHW) are highly effective in stroke risk factor education and management (Brownstein et al., 2005).

Given the CHW model's unique ability to improve cultural competency and health literacy in disadvantaged communities, it has been actively pursued as an effective means of reducing heart disease and stroke disparities among these populations (Allen et al., 2015; Brownstein et al., 2005). In the United States, CHW–led stroke interventions haven proven highly effective in reducing risk factors (hypertension, diabetes, cholesterol) and increasing healthy behaviors (improved body weight, physical activity (PA), healthy eating and smoking cessation) among individuals at high–risk for CVD and stroke (Brownstein et al., 2005;

Brownstein et al., 2007; Covert et al., 2019; CTSF, 2015; Towfighi et al., 2017). However, for successful implementation of interventions, CHWs need to be prepared with solid initial training, rigorous competency assessments, on–going monitoring, and continued education (Kapheim & Campbell, 2014).

Having found such strong evidence in the literature on CHW effectiveness in stroke and CVD prevention, this scoping review sought out to analyze the training and assessment methods used to employ CHWs. No comprehensive review is available in the literature regarding CHW training and competency assessment methods in stroke and CVD prevention. The purpose of the review was to: 1) provide a summary of competency assessment methods used in stroke focused CHW training programs in the country, and 2) identify existing CHW validated assessment tools for knowledge and skills in stroke and cardiovascular risk factors. Specifically, this review aimed to synthesize the types of assessment tools used to measure CHW competencies in the seven MRFs for stroke, to explore if such assessment tools were validated, to describe the psychometric properties of the instrumentation, and results on performance outcomes.

Because of the broad and heterogeneous nature of the CHW field, a scoping review of the literature was conducted to understand key concepts and identify gaps in knowledge. Using Arksey and O'Malley's (2005) five–stage framework for scoping reviews, databases for literature on competency assessment methods used in CHW training programs in the United States were reviewed (Arksey & O'Malley, 2005).

Methods

Search Strategy and Inclusion Criteria

This scoping review adheres to the Preferred Reporting Items for Systematic reviews and Meta–Analyses (PRISMA) guidelines (Moher et al., 2009). Six online databases were searched from inception to January 2021: PubMed, Cochrane, CINAHL, Embase, Web of Science, and HAPI. The search was conducted with an algorithm that included various keywords and subject headings to capture articles relevant to the review. All database searches included articles that resulted from any combination of three vague terms from each search category: 1) "Community Health Workers," 2) "Stroke Modifiable Risk Factors," and 3) "Training and Assessment Methods." We only included papers published in English since 1960 (Gunderson et al., 2018), studies conducted in the U.S., papers with primary participants as CHWs, studies that defined CHWs, papers focusing on any of the "Stroke Modifiable Risk Factors" (i.e., the simple 7—diabetes, hypertension, high blood cholesterol, cigarette smoking, obesity, physical activity, and/or nutrition), as well as stroke preparedness. In addition, the search was limited by only including papers focusing on CHW training methods and/or evaluation, and papers explicitly stating that the aims or objectives of the study were to evaluate competencies of CHWs who were trained in stroke or CVD prevention. Lastly, papers must focus on assessment tools to test CHW competencies (i.e., assessment, instrument, test, tool, and questionnaire) to be included in the review. Papers that are not original, full–text, research studies (e.g., commentaries, letters, opinion pieces, study protocols, training needs assessments, and conference proceedings with only an abstract available) were excluded.

Screening of Abstracts and Full–Text Citations

The search yielded 1,957 articles. Six hundred and eighty–one references were removed during the deduplication process in two web resources: EndNote reference management software and Covidence systematic review software. 1,093 articles were screened against titles and abstracts, removing 980 articles as they did not satisfy the inclusion criteria. The remaining 113 articles were independently reviewed by two authors (JM and RDL) for eligibility and inclusion in the review. Fifty–three articles met the original criteria for inclusion and were further reviewed with the new inclusion criterion: studies utilizing tools to assess CHW competencies. Twenty–four articles met the new eligibility criteria and were included in the review. During full–text review, discrepancies were resolved through discussion, and a consensus was achieved between the reviewers. All reference lists of the included articles were checked for pertinent citations that might not have been identified in the main online query of electronic databases. Through this ancestry method of cross–checking and back–referencing, we ensured comprehensiveness (Wohlin, 2014). As a result, we added six more references, resulting in a total of 30 articles included in the review (Figure 2.1).

Data Extraction

A standardized form was created to systematically extract the following data from the full–text articles: authors and publication year, study location and setting, study aims, training methods, competency assessment methods (i.e., type of assessment), instrumentation, and results. Data on the general characteristics of the studies, including location, aims, key aspects of training, training methods, competency assessment methods and results were extracted (Table 2.1).

The scope of the studies extracted were limited to CHW training in one or more seven MRFs for stroke. Studies that trained CHWs in a comprehensive CVD or stroke risk factor prevention were also included as it covered one or more of the seven MRFs. Also, the competency measures and instrumentation used to assess CHWs in these topics were included.

Analysis of the assessment measure or tool characteristics included: stroke risk factor assessed, research discipline where the tool was generated, reliability, validity, if tested, intended users, whether the tool was for assessing knowledge, skills, or self–efficacy and or all, and additional comments. Data extracted from the 30 articles with the assessment methods are included in Table 2.1.

Different terms for CHWs (including community health advocate, promotores, and community peer leaders) are used in the studies—the term CHW will be used as an umbrella term in this review to describe all lay health worker studies that fit the inclusion criteria for this review.

Figure 2.1. PRISMA Flowchart of Study Selection

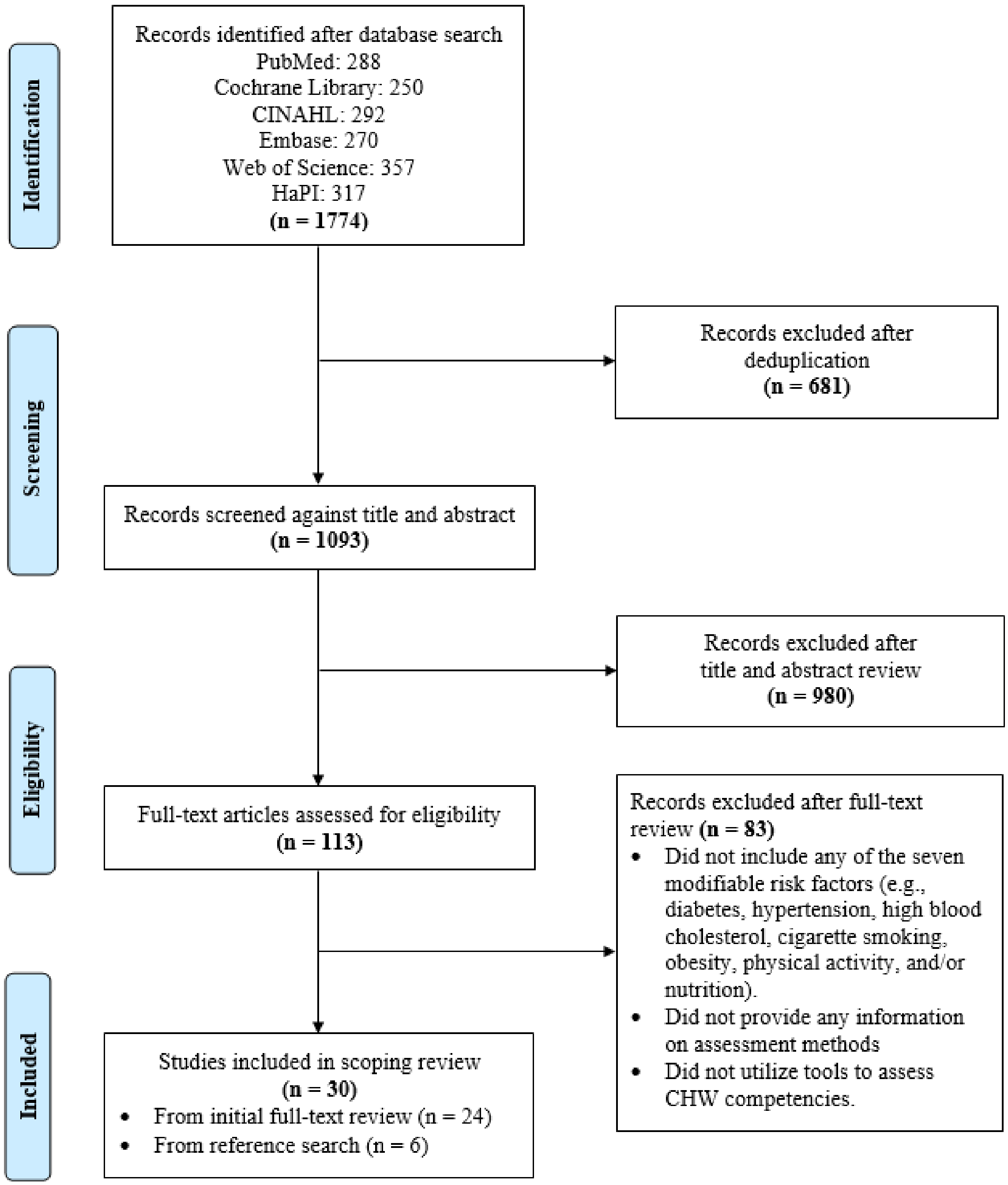

Table 2.1. Summary of Extracted Studies

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Balcazar et al., 2006	Multisite, USA (Illinois, California, New Mexico) Urban.	To implement the Salud Para Su Corazón (Health For Your Heart)—promotora program for promoting heart–healthy behaviors among Latinos	Cardiovascular risk factors	CHW didactic training Train–the–Trainer Model "Your Heart, Your Life" curriculum	Pre–post test	Knowledge and Self–skills	Mixed results. Positive outcome for heart health knowledge with closed test format. Statistically significant results of the self–assessment skills of promotora knowledge and performance as community health educators	Independently developed Tool called Cuéntamelo; 8–item heart health knowledge, 22–item Likert–type scale to assess personal characteristics and performance skills

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Bouchonville et al. 2018	New Mexico, USA. Rural.	To determine whether participation in tele mentorship model of healthcare delivery improves primary care provider (PCP) and CHW confidence in managing patients with complex diabetes in medically underserved regions	Diabetes	CHW didactic training via teleECHO & practice–based learning through case presentations	Pre–post test	Self–efficacy	Positive outcome. Significant improvement in self–efficacy in all measures of complex diabetes management	Independently developed 11–item Likert Scale Self–Efficacy Survey for Diabetes Management

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Boutin–Foster et al., 2008	Brooklyn, New York, USA. Urban.	To educate CHWs and frontline service providers factors and signs & symptoms for heart disease and stroke	Cardiovascular disease and Stroke	CHW didactic training	Post test	Knowledge	Positive outcome for knowledge on cardiovascular disease	Independently developed 11 items on CVD and stroke signs & symptoms
Bustillos et al., 2015	Texas–Mexico Border, USA. Rural.	To implement a culturally and linguistically centered nutrition education program by promotoras to improve knowledge in their communities	Nutrition	Promotora didactic training	Pre–post tests	Knowledge and Self–efficacy	Positive outcome. Statistically significant increase in nutrition knowledge and self–efficacy	Independently developed MCQ +T/F on nutrition knowledge, 15–question interview guide focus group

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Colleran et al., 2012	New Mexico, USA. Rural.	To determine whether an innovative interactive distance training program; ECHO (Extension for Community Healthcare Outcomes) is an effective modality to train community health workers in diabetes management	Diabetes	CHW didactic training	Pre–post tests	Knowledge, and Self–efficacy	Positive outcome. Significant improvements in diabetes knowledge, attitudes and confidence in both clinical and nonclinical skills	Validated instruments & Independently developed Modified Diabetes Knowledge Test (DKT2)*; Diabetes Attitude Survey (DAS)*; the Diabetes Confidence Survey (DCS)

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Cornell et al., 2009	Alabama, USA. Rural.	To train and Community Health Advisors (CHAs) in conducting a theory–based intervention designed to reduce the risk for cardiovascular disease (CVD) among rural African–American women	Cardiovascular risk factors	CHA didactic training	Pre–post test	Knowledge, Self–efficacy, Self–behaviors	Positive outcome. Increases in knowledge about reducing CVD risk and in self–efficacy and behaviors related to giving advice and assistance about risk reduction strategies to others	Independently developed No details provided

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Cruz et al., 2013	Multisite, USA (Texas, California, Washington DC) Urban.	To train CHWs in the Diabetes Empowerment Education Program (DEEP) to provide diabetes education to Hispanic population in their community	Diabetes	Promotores didactic training & Semi–annual refresher trainings	Pre–post test	Knowledge	Positive outcome. Increase in diabetes knowledge, risk factors, prevention and control	Independently developed 20 questions on diabetes risk factors, and methods for prevention and control. Content and face validity established.

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Ferguson et al., 2012	Massachusetts, USA. Rural.	To implement and evaluate a CHW training program to deploy them into diabetes care teams in community health centers	Diabetes	CHW didactic & ongoing training every 6 weeks via conference calls	Pre–post test	Knowledge, Skill, Confidence	Mixed results. Statistically significant improvement in knowledge after training. Greatest improvement in evaluation and empowerment skills in diabetes goal setting. No significant score improvement in diabetes self–management	Independently developed Four–point Likert scale (strongly agree–disagree)

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Han et al., 2007	Baltimore, USA. Urban.	To examine the effects of a CVD and stroke prevention training program on CHWs' knowledge, counseling skills and attitudes regarding community volunteerism using both quantitative and qualitative approaches	Cardiovascular disease and Stroke	CHW didactic training	Post test	Knowledge, Skills,	Positive outcome. Minimum required level of 70% for both hypertension and diabetes knowledge tests met. Independent observational ratings of CHW counseling skills by two trainer judges revealed that overall CHW performance was at a satisfactory level	Validated instruments & Independently developed NHLBI's HKT, (DKT)*, independently developed CHW satisfaction survey (open–ended questions and several Likert–type scales); 9–item core competencies four–point scale (1= performance fails to meet standards, 4= performance exceeds standards) from CA DOE. Trainer observation scales to evaluate CHW counseling skills

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Harvey et al., 2009	Detroit, USA. Urban.	To train CHWs known as Health Connectional Advocates (HCAs) to encourage African American and Latina women from their existing social networks to obtain screening for type 2 diabetes and hypertension	Diabetes and Hypertension	HCA didactic training, field demonstration & monthly ongoing training	Post test	Knowledge, Skills	Positive outcome. All 8 HCAs passed the written examination with score of at least 80%	Independently developed Knowledge assessed with written exam. Skills assessed by ability to demonstrate BP and blood glucose testing and make recommendations following AHA and ADA guidelines

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Haughton et al., 2015	San Diego, California, USA. Urban.	To describe the recruitment, selection, training, and evaluation of CHWs in a PA intervention program	Physical Activity	CHW didactic training, Booster sessions on MI and impact of built environment on PA	Post test	Skills	Positive outcome. Fidelity assessment for quality of all class instruction was high, with a mean score on the Instructor Behavior Checklist of 19.4 (SD = 2.3) of 23 with need for improvement in warmup and cool downs	Validated instrument The System for Observing Fitness Instruction Time for Group Exercise Classes (SOFIT–X)* instrument

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Hill–Briggs et al., 2007	Baltimore, USA. Urban.	To describe procedures used to recruit, train, and evaluate a nurse case manager and CHW team intervention designed to improve diabetes care and control in urban African Americans	Diabetes	CHW didactic training & Field Experience	Post test	Knowledge, Skills	The CHWs satisfactorily passed each of the certification tests. Core training in study policies and procedures, technical skills, and diabetes education was not sufficient for CHWs to perform the role of health educator. An extended training was necessary to and to promote CHW self–efficacy	Independently developed Certification tests to assess knowledge and/or skill acquisition in fill–in–the blanks, multiple choice, yes/no, and short answer format; Skills observation of BP measurement, and home visits

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Josiah Willock et al., 2015	Georgia, USA. Urban.	The train to address the increased risk of heart disease among African American women in the local priority area	Cardiovascular disease and Stroke	CHW didactic training, Modified WEHL curriculum, Learning Circle approach	Pre–post test	Knowledge, Skills, Perceptions, Confidence	Negative outcome. No significant change in overall group heart health knowledge scores from pretest to posttest. Significant increase in knowledge and confidence was associated in CHWs with prior experience in teaching cardiovascular topics	Independently developed / Questions from curriculum Knowledge questionnaire (correct response=1 and incorrect response=0) with maximum score of 27. Skills assessment of confidence in teaching the curriculum

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Kuhajda et al., 2006	Alabama, USA. Rural.	To (i) revise the Women's Wellness Sourcebook Module III: Heart and Stroke (ii) train CHWs using the revised curriculum; and (iii) evaluate the training program	Cardiovascular disease and Stroke	CHW didactic training Revised Women's Wellness Sourcebook Module III: Heart and Stroke Curriculum	Pre–post test	Knowledge, Attitudes, Self–efficacy, and Self–reported risk reduction behaviors	Positive outcome. CHWs showed increases in knowledge, self–efficacy, attitudes, and self–reported behaviors. At the end of training, all CHWs were comfortable with their counseling and assessment roles.	Independently developed/ Questions from curriculum Knowledge questionnaires in MCQ, T/F, SA questions, and oral question–and–answer periods format. Self–efficacy questions of CHWs comfort level and confidence using Likert scales (1=not at all comfortable/not at all sure– 10= very comfortable/or very sure). Skills acquisition were evaluated by roles plays and observation

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Lautner et al., 2019	Texas, USA. Urban.	To adapt and develop a tobacco–focused CEU for CHWs to provide them with the knowledge and skill sets needed to inform their communiti es about tobacco cessation	Smoking/ Tobacco Cessation	CHW didactic training "Tobacco Cessation: The Key to a Healthier You!" curriculum	Pre–post test	Knowledge	No details provided	Independently developed/ Questions from curriculum No details provided

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Look et al., 2008	Hawaii, USA. Rural.	To train in diabetes prevention and control (CHWs) serving Native Hawaiian and Pacific People in Hawai‘i	Diabetes	CHW didactic training	Pre–post test	Knowledge, Satisfaction	Positive outcome. Overall statistically significant improvement in mean test scores. The satisfaction survey results indicated a high rate of approval with the course	Validated instruments Adapted DAS–3 & DKT. 11 straight–forward and nontechnical questions: 8 MCQs, 3T/F with short explanation. The satisfaction surveys asked 3 short answer questions and 9 statements (3–point Likert scale of agreement or disagreement)

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Martinez Bristow et al., 2006	El Paso, Texas, USA. Rural.	To deliver the Tobacco Free El Paso to promotores to train them as tobacco cessation counselors	Smoking/ Tobacco Cessation	CHW didactic training Tobacco Free El Paso's curriculum	Pre–post test	Self–confidence	Positive outcome. Significant increase in satisfaction scores indicating sufficient self–confidence to deliver a brief smoking cessation intervention	Independently developed/ Questions from curriculum Likert scale to measure participants' self–confidence and satisfaction with the course (1=very low; 5=very high)
McCloskey et al., 2009	New Mexico, USA. Rural.	To evaluate the role of *LA VIDA* promotores in reducing diabetes health disparities among Hispanics in New Mexico	Diabetes	Promotores didactic training & Field experience	Pre–post test	Knowledge	No details provided	Independently developed No details provided

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Moleta et al., 2017	Hawaii, USA. Rural.	To determine if an interactive and culturally relevant CVD program for CHWs would lead to an increase in CVD knowledge and long–term information competency	Cardiovascular disease	CHW didactic training	Pre–post test and delayed post test	Knowledge, Satisfaction	Positive outcome. The significant increases in mean test scores from T1 to T2 demonstrate significant gains in knowledge, while the increase in mean test score from T1 to T3 indicate meaningful long–term information competency	Validated instruments Adapted from Dutch Heart Failure Knowledge Scale and the Coronary Heart Disease Knowledge Test*; 16 MCQs on cardiovascular physiology, disease, and treatment selected from two validated instruments; A two–part participant satisfaction evaluation at the conclusion of the seminar

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Policicchio et al., 2018	Michigan, USA. Rural.	To improve the knowledge and skills of community health workers (CHWs) in management of diabetes to work more effectively with individuals in the community with diabetes	Diabetes	CHW didactic training, CDC's CHW Training Resource on Heart Disease and Stroke curriculum guided by the Plan, Do, Study Act improvement model	Pre–post test	Knowledge, Skills, Satisfaction	Positive outcome. Overall, knowledge increase with largest changes in diabetes, depression and cholesterol. Diabetes attitudes were high and consistent with caregivers who support patient–centered care. Participants reported liking the class, and finding the materials helpful	Validated instruments The DKT*–23MCQs, DAS*–33–item 5–point Likert scale; 10–point satisfaction scale survey. Pre and posttest from each of the chapters in the CDC curriculum. Standard assessment checklists for glucose testing, blood pressure screening and foot assessment

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Prezio et al., 2013	Dallas, Texas, USA. Urban.	To determine the impact of a culturally tailored diabetes education program led by a CHWs on HbA1c, BP, BMI and lipid status among uninsured Mexican Americans	Diabetes	CHW didactic training, CoDE curriculum	Post test	Knowledge, Skills	No details provided	Independently developed Written knowledge test, clinical skills observation

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Pullen Smith et al., 2008	North Carolina, USA. Urban.	To demonstrate CHAs training and education in improving diabetes awareness, management, and prevention	Diabetes	CHA didactic training, CHAP manual, 2.0 CEU credits were awarded to CHAs on successful completion of requirements by local community college	Pre–post test and delayed post test	Knowledge, Skills lab assignments	No details provided	Independently developed/ Questions from CHAP manual 10–item knowledge pretest at week 1 on signs of diabetes, types of diabetes, blood glucose, types of wounds, and local resources; 20–item test on knowledge of concepts taught during week 1; 8–item posttest on how to use the CHAP manual
Swider et al., 2010	Chicago, USA. Urban.	To describe training and evaluation of a promotora intervention focused on diabetes self–management	Diabetes	Didactics in DEEP curriculum & modified version of Lorig et al's Chronic Disease Self–Management Program	Post test	Knowledge, Skills, Self–efficacy	Positive outcome. Increased knowledge and skills post training	Independently developed/ Questions from DEEP curriculum 9–item review form (1=lowest to 5=highest) on the self–management content and skills. Skills observation via role play

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Tang et al., 2011		To describe the training of peer leaders to facilitate an empowerment based diabetes self–management support intervention	Diabetes	Peer Leader Competency–based training	Pre–post test	Knowledge, Skills, Self–efficacy	No details provided	Validated instruments DKT*, (DKQ)*, 5–point Likert–scale on the UMPS, 6 empowerment–based facilitation video vignettes, 5–point scale on an adapted version of the Active Listening Observation Scale–global, 5–point scale on a self–efficacy scale adapted from Heisler and Piette, Active listening skills assessed by standardized patient interview simulation that instructs participants to conduct a 15–minute interview with a patient using the 5–step goal–setting process

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Valen et al., 2012	Minnesota, USA. Rural.	To increase diabetes related knowledge of community health workers employed in a migrant clinic and prepare them to provide diabetes education	Diabetes	CHW didactic	Pre–post test	Knowledge	Positive outcome. Pre–post knowledge scores demonstrated a change in the desired direction (mean pre–post test score change of 8.5). CHWs reported increased confidence in their ability to educate patients	Independently developed 22–item, MCQ tool developed by first author based on materials from ADA was used. Topics covered in the tool included diabetes knowledge, complications, hypoglycemia, hyperglycemia, nutritional management, and PA

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Vaughan et al., 2020	Texas, USA. Urban.	To evaluate the feasibility and acceptability of weekly training and support by telemedicine for CHWs in diabetes management	Diabetes	CHW didactic training, Living a Healthy Life with Chronic Conditions curriculum	Pre–post test and delayed post test	Knowledge, Satisfaction	Positive outcome. Increase in knowledge scores from pre– to posttest (scores range 4–8 points) and baseline to 6months. All CHWs (n=6) preferred training and support by telemedicine in lieu of prior in–person sessions and liked meeting each week. High satisfaction with the training content of training,	Validated instruments 23–item DKT*; CHW satisfaction as measured by the Texas Department of State Health Services with 10–item training quality survey on a 6–point Likert scale (1=poor, 6=excellent); 21–item Telehealth Usability Questionnaire to measure feasibility and acceptability

	instructor training ability, expertise and objectives. High ranking in the telehealth usability and satisfaction

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Wagner et al., 2020	Connecticut, USA. Urban.	To report pre–post pilot of a peer–learning intervention between CHWs in the USA and Village Health Support Guides (Guides) in Cambodia to improve outcomes for Cambodians with type 2 diabetes	Diabetes	Train–the–Trainer Model Peer–Learning Eat, Walk, Sleep (EWS) curriculum Didactic sessions via videoconferencing	Pre–post test	Knowledge, Attitudes, Satisfaction	US–CHWs and Cambodia–Guides showed improved knowledge, self–evaluations, and attitudes toward using technology for learning. For the US CHWs (n=2) the % correct from baseline to post training were: knowledge 78.0–98.0; satisfaction 32.0–39.0; evaluation 32.0–37.0; attitudes 33.5–48.0	Independently developed / Questions from EWS curriculum 10–item job satisfaction survey; 12–item survey of technology attitudes; 10–item self–evaluation scale. A 25–item diabetes knowledge (previously validated in Cambodia) consisting of T/F/don't know options, yielding a score from 0 to 25 with higher scores indicating more knowledge. A 10–item core self–evaluation scale rated on a 4–point Likert scale (not at all–extremely)

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Walton et al., 2012	Dallas, Texas, USA. Urban.	To describe a CHW–led diabetes self–manageme nt education program targeting Hispanic patients	Diabetes	CHW didactic training DEP adapted from CoDE curriculum	Post test	Knowledge	All 5 CHWs completed the 50 hours of additional training in diabetes management and DEP implementat ion and passed a posttest on diabetes knowledge with an average score of 96.8%	Independently developed/Questions from CoDE curriculum Knowledge assessment of the Texas CHW curriculum and a posttest developed by a BHCS certified diabetes educator to assess knowledge gained pertaining to diabetes management and the DEP protocol

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Woodruff et al., 2010	San Diego, California, USA. Urban.	To examine the feasibility of using CHAs to deliver two innovative, relatively complex cognitive/ behavioral tobacco control interventions in the San Diego Latino community	Smoking/ Tobacco Cessation	CHA didactic training, role–playing, skills development, MI, and ongoing mastery testing of the intervention curriculum	Pre–post test	Knowledge, Psychosocial measures	CHAs in both interventions showed increased knowledge. Self–esteem scores for CHAs in Proyecto Sol stayed same pre–to–post, but scores for Ambiente Fresco CHAs increased; Proyecto Sol CHA scores were slightly higher at baseline	Independently developed Psychosocial construct items measured on a scale from 1 (Disagree) to 5 (Agree). Middle response categories did not have verbal anchors. True/false items were developed to measure ETS–related knowledge (8 items) and smoking cessation knowledge (11 items), with all CHAs answering all 19 items. Two knowledge scores were computed as the percent answered correctly

[1]Author(s) and Publication Year	Study Location and Setting	Study Aims	Target Training Intervention	Key Aspects of CHW Training Methods	Competency Assessment Design	Competency Assessed	Results	Instrumentation*
Zurawski et al., 2016	New Mexico, USA. Rural.	To describe Project ECHO (Extension for Community Healthcare Outcomes), using CHWs in a the Diabetes management program	Diabetes	CHW skills–focused training	Pre–post test	Knowledge, Attitude, Confidence, Program evaluation	Positive outcomes. Increase in knowledge from pre–training to post–training using DKS. Changes in attitude (seriousness and the psychosocial impact of diabetes, and the value of tight control) were not observed measured by (DAS–3). Participants reported relatively high scores in the pre–survey, with small and	Validated instruments The Diabetes Knowledge Scale (DKS) adapted from the Michigan Diabetes Knowledge and the Michigan Diabetes Attitude Scale (DAS–3)

	statistically insignificant increases after participation in the training

[1]The Objectives, Methods, Results and Conclusions were taken from the abstracts of the papers included in this review. Small modifications were made for brevity and consistency across papers. * Described in detail in Table 2.3.

Note: CHW– community health worker; CHA– community health advisors (CHAs); CVD– cardiovascular disease BP– blood pressure; DKT– diabetes knowledge test; HKT– hypertension knowledge test; DAS– diabetes attitude scale; DCS– diabetes confidence scale; DKS– diabetes knowledge scale; DKQ–diabetes knowledge questionnaire; PA– physical activity, ADA–American Diabetes Association; CDC– Centers for Disease Control; MCQ– multiple choice questions; AHA– American Heart Association; T/F– true or false; ETS– environmental tobacco smoke; UPMS–Understanding Management Practice Scale

Results

The inclusion criteria required CHW trainings to have a focus on at least one of the seven modifiable risk factors. Because of the common risk factors for stroke and CVD, studies that focused on CVD risk factors were also included. A total of 30 studies met the inclusion criteria for this review (Figure 1). The most common reason for exclusion was that studies did not utilize tools to assess CHW competencies. The studies included in this review were published between 2006 and 2020. A summary of the studies that met eligibility criteria are included in Table 2.1.

Characteristics of Included Studies

Table 2.2 summarizes the characteristics of the included studies. Of the 30 studies included, 7 (23%) focused on stroke and CVD (Balcazar et al., 2006; Boutin–Foster et al., 2007; Cornell et al., 2009; Han et al., 2007; Josiah Willock et al., 2015; Kuhajda et al., 2006; Moleta et al., 2017); 18 studies (60%) were focused on diabetes (Bouchonville et al., 2018; Colleran et al., 2012; Cruz et al., 2013; Ferguson et al., 2012; Hill–Briggs et al., 2007; Look et al., 2008; McCloskey, 2009; Policicchio & Dontje, 2018; Prezio et al., 2013; Pullen–Smith et al., 2008; Swider et al., 2010; Tang et al., 2011; Valen et al., 2012; Vaughan et al., 2020; Wagner et al., 2020; Walton et al., 2016; Zurawski et al., 2016); 3 studies (10%) on smoking and or tobacco cessation (Lautner et al., 2019; Martinez–Bristow et al., 2006; Woodruff et al., 2010); 1 study (3%) on DM and HTN (Harvey et al., 2009); one study (3%) on physical activity (Haughton et al., 2015); and one study (3%) on nutrition (Bustillos & Sharkey, 2015).

Training Methods

The most widely used method was the didactics employed by 24 of the 30 studies (Balcazar et al., 2006; Boutin–Foster et al., 2007; Bustillos & Sharkey, 2015; Colleran et al., 2012; Cornell et al., 2009; Cruz et al., 2013; Ferguson et al., 2007; Han et al., 2007; Haughton et al., 2015; Josiah Willock et al., 2015; Kuhajda et al., 2006; Lautner et al., 2019; Look et al., 2008; Martinez–Bristow et al., 2006; Moleta et al., 2017; Policicchio & Dontje, 2018; Prezio et al., 2013; Pullen–Smith et al., 2008; Swider et al., 2010; Valen et al., 2012; Vaughan et al., 2020; Wagner et al., 2020; Walton et al., 2012; Woodruff et al.,2010), another three studies used a field experience component in addition to didactic sessions (Harvey et al., 2009; Hill–Briggs et al., 2007; McCloskey, 2009). The other methods utilized were practice–based training (Bouchonville et al., 2018), competency–based training (Tang et al., 2011) and skills–focused training (Zurawski et al., 2016). All of these trainings were either delivered by experts or peer CHWs. While majority of the trainings were delivered in–person, some were delivered remotely via teleconferencing and/videoconferencing (Bouchonville et al., 2018; Colleran et al., 2012; Vaughan et al., 2020; Wagner et al., 2020; Zurawski et al., 2016). Innovative approaches such as peer leader training (Tang et al., 2011), train–the–trainer model (Balcazar et al., 2006; Wagner et al., 2020), and the learning circle approach (Josiah Willock et al., 2015) were also utilized.

Twelve of the 30 studies reported the use of training curriculum designed for CHWs including National Heart Lung and Blood Institutes' (NHLBI) "your heart, your life" (Balcazar et al., 2006), NHLBI's modified "With Every Heartbeat Is Life" (WEHL) (Josiah Willock et al., 2015), Revised Women's Wellness Sourcebook Module III: Heart and Stroke (Kuhajda et al., 2006), Centers for Disease Control and Prevention CHW Training Resource on Heart Disease and Stroke (Policicchio & Dontje, 2018), Community Diabetes Education (CoDE) program curriculum (Prezio et al., 2013), North Carolina Office of Minority Health and Health Disparities Community Health Ambassador Program (CHAP) manual (Pullen–Smith et al., 2008), Diabetes Self–Management Education Curriculum (Program de Educación y Desarrollo de Destrezas sobre Diabetes [DEEP]) (Swider et al., 2010), Living a Healthy Life with Chronic Conditions curriculum (Vaughan et al., 2020), Eat, Walk, Sleep (EWS) curriculum (Wagner et al., 2020), adapted CoDE curriculum (Walton et al., 2012), “Tobacco Cessation: The Key to a Healthier You!” (Lautner et al., 2019), and Tobacco Free El Paso’s curriculum (Martinez–Bristow et al., 2006).

Competency Assessment Methods

In this review, three main CHW competencies were assessed: knowledge, skills, and traits. Majority of the studies (29 of 30) (Balcazar et al., 2006; Bouchonville et al., 2018; Boutin–Foster et al., 2007; Bustillos & Sharkey, 2015; Colleran et al., 2012; Cornell et al., 2009; Cruz et al., 2013; Ferguson et al., 2007; Han et al., 2007; Harvey et al., 2012; Hill–Briggs et al., 2007; Josiah Willock et al., 2015; Kuhajda et al., 2006; Lautner et al., 2019; Look et al., 2008; Martinez–Bristow et al., 2006; Moleta et al., 2017; Policicchio & Dontje, 2018; Prezio et al., 2013; Pullen–Smith et al., 2008; Swider et al., 2010; Tang et al., 2011; Valen et al., 2012; Vaughan et al., 2020; Wagner et al., 2020; Walton et al., 2012; Woodruff et al., 2010; Zurawski et al., 2016) assessed knowledge with written assessments using multiple–choice test, true/false, fill–in–the–blanks, short answers, oral question and answers, surveys, and/or open–ended questionnaire formats. Sixteen studies also assessed CHW traits such as: Self–efficacy (Bouchonville et al., 2018; Bustillos & Sharkey, 2015; Colleran et al., 2012; Cornell et al., 2009;

Kuhajda et al., 2006; Swider et al., 2010; Tang et al., 2011); Confidence (Ferguson et al., 2012; Josiah Willock et al., 2015; Martinez–Bristow et al., 2006; Zurawski et al., 2016); Self–skills (Balcazar et al., 2006); Attitudes (Kuhajda et al., 2006; Wagner et al., 2020; Zurawski, Komaromy, Ceballos, McAuley, & Arora, 2016); Behaviors (Cornell et al., 2009; Kuhajda et al., 2006); Perceptions (Josiah Willock et al., 2015).

Among the studies that assessed skills (n=10) a variety of assessment methods were used including: fidelity assessments for quality of physical activity classes (Haughton et al., 2015), active listening skills of peer leaders using a standardized patient interview simulation (Tang et al., 2011), and trainer observation scales to evaluate counseling skills (Han et al., 2007). Other methods included assessing CHW confidence and ability to grasp and reteach training material (Josiah Willock et al., 2015), observation of blood pressure and blood glucose measurement with standard checklists or mock assessments (Harvey et al., 2012; Hill–Briggs et al., 2007; Policicchio & Dontje, 2018; Prezio et al., 2013; Pullen–Smith et al., 2008), lab assignments in wound evaluation (Pullen–Smith et al., 2008), role–plays (Hill–Briggs et al., 2007; Swider et al., 2010) and observation of home visits (Hill–Briggs et al., 2007).

Overall, regardless of the competency that was assessed, the outcomes were reported to be positive indicating the significance of structured training and assessment methods.

Table 2.2. Characteristics of Included Studies (n=30)

Study Characteristics	**n (%)**
Training Topic	
CVD & Stroke Risk Factors	7 (23%)
Diabetes	17 (56%)
Diabetes & Hypertension	1 (3%)
Nutrition	1 (3%)
Physical Activity	1 (3%)
Tobacco/Smoking Cessation	3 (10%)
Training Feature	
Didactic Lessons only	24 (80%)
Didactics + Field Experience	3 (10%)
Skills–Focused	1 (3%)
Practice–based	1 (3%)
Competency–based	1 (3%)
Assessment Design	
Pre –post test	20 (66%)
Post test	8 (26%)
Pre –posttest & delayed post test	3 (10%)
Competency Assessed	
Knowledge	27 (90%)
Skills	10 (33%)
Traits (attitudes, behaviors, confidence, self–efficacy, self–skills, perceptions)	19 (63%)
Satisfaction Surveys	6 (20%)
Type of Assessment	
Written Assessments	29 (96%)
Behavior–based Assessments	7 (23%)
Focus Groups	3 (10%)
Interviews	3 (10%)
Instrumentation	
Validated	9 (30%)
Independently Developed/ Questions from Training Curriculum	21 (70%)

Instrumentation

Out of the 30 articles included in the review, only 9 studies used a validated instrument for assessing CHW competencies (Colleran et al., 2012; Han et al., 2007; Haughton et al., 2015; Look et al., 2008; Moleta et al., 2017; Policicchio & Dontje, 2018; Tang et al., 2011; Vaughan et al., 2020; Zurawski et al., 2016). The most common validated instrument used was the Diabetes Knowledge Test (DKT), which was utilized by six out of the 9 studies (Colleran et al., 2012; Han et al., 2007; Look et al., 2008; Policicchio & Dontje, 2018; Tang et al., 2011; Vaughan et al., 2020). The other validated instruments used were the Diabetes Attitude Scale (DAS) (Colleran et al., 2012; Look et al., 2008; Policicchio & Dontje, 2018; Zurawski et al., 2016); Diabetes Knowledge Questionnaire (DKQ) (Tang et al., 2011); Coronary Heart Disease Knowledge Test (Moleta et al., 2017); and System for Observing Fitness Instruction Time for Group Exercise Classes (SOFIT–X) (Haughton et al., 2015).

The concepts included in these six validated instruments were general diabetes knowledge (Fitzgerald et al., 1998; Fitzgerald et al., 2016; Garcia et al., 2001), attitudes toward diabetes management (Anderson et al., 1989), risk factors for coronary heart disease (Smith et al., 1991) and fidelity of PA classes (Duesterhaus, 2011). Although these instruments reported valid psychometric properties, none of them were designed for the CHW population and show no evidence of being applicable to them.

A summary of these six validated instruments and their psychometric properties is provided in Table 2.3.

Table 2.3. Description of Validated Instruments

Instrument	Developer(s) Title	Purpose & Population	Description	Psychometric Properties	Number of studies that have used it
Diabetes Knowledge Test (DKT)	Fitzgerald et al., (1998). The Reliability and Validity of a Brief Diabetes Knowledge Test	Diabetes knowledge in patients with type 1 and type 2 diabetes	23–item multiple choice test (14–items on type 1 and type 2 diabetes and 9–items on insulin–use); 13 items modified in DKT2	Internal Consistency Reliability Coefficient (Cronbach's $\alpha \geq 0.70$) for both subscales	6
Modified Diabetes Knowledge Test (DKT2)	Fitzgerald et al., (2016). Validation of the Revised Brief Diabetes Knowledge Test (DKT2)				
Diabetes Attitude Scale (DAS)	Anderson et al., (1989). Development of Diabetes Attitude Scale for Health–Care Professionals. Diabetes Care	Diabetes attitudes of health care professionals	31–items with a five–point Likert Scale to measures participant beliefs in five areas: the need for special training, the seriousness of noninsulin dependent diabetes mellitus, the value of tight control, the psychological impact of diabetes, and patient autonomy	Content validity established. Internal Consistency Reliability Coefficient (Cronbach's $\alpha = 0.83$)	4
Diabetes Knowledge Questionnaire (DKQ)	Garcia et al., (2001). The Starr County Diabetes Education Study: Development of the Spanish–language diabetes knowledge questionnaire, in Diabetes Care	Diabetes knowledge in Mexican–American patients with type 2 diabetes	24–item measure of general diabetes knowledge with possible responses of "yes", "no", and "I don't know"	Construct validity established. Internal Consistency Reliability (Cronbach's $\alpha = 0.78$)	1

Instrument	Developer(s) Title	Purpose & Population	Description	Psychometric Properties	Number of studies that have used it
Coronary Heart Disease Knowledge Test	Smith et al., (1991). Coronary Heart Disease Knowledge Test	Cardiac patients' knowledge on coronary heart disease and its risk factors	40–item multiple choice test on coronary heart disease and its risk factors	Content validity established. Internal Consistency Reliability (KR20= 0.82)	1
System for Observing Fitness Instruction Time for Group Exercise Classes (SOFIT–X)	Duesterhaus (2011). A system for observing fitness instruction time in group–exercise classes (SOFIT–X). Unpublished master's thesis, San Diego State University, San Diego, CA	Quality indicator tool for adult group–based PA classes	SOFIT–X is a 4–phase decision system. Observers code participants' posture, intensity, class context, and instructor behavior during each 10–second record interval	Content and Criterion validity established. Acceptable inter–rater reliability between two observers for reliability checks PA classes	1

Discussion

The aim of this study was to review and synthesize existing competency assessment methods used in stroke–focused CHW training programs. Results of this scoping review drew on data from 30 studies that trained CHWs in one or more of the seven MRFs for stroke. The training methods employed in each of the studies varied in content, methods, number of trainees, length, and scope. As stated in previous literature, this variation is seen because of the lack of rigidity in training standardization within the CHW field. Because of the complexity of the CHW roles and duties, especially in chronic disease prevention, researchers often rely on context–dependent design of training programs.

For any healthcare workforce training in complex chronic disease concepts, it is essential to assess the trainee's competencies—i.e., possession of sufficient knowledge and capabilities to perform specific tasks to produce desirable outcomes (Kak, 2001). For those responsible for frontline health implementation, such as CHWs, this implies the acquisition of knowledge, skills, and abilities through training, hands–on practice, and work experience. In addition, for CHWs, their innate 'traits' such as self–efficacy and self–confidence also influence their performance.

The scoping review of these 30 studies revealed that CHWs were assessed for knowledge, skills, and/ traits such as self–efficacy in preparation for their outreach and health education activities. The assessment methods used were mostly derived from the training curriculum or independently developed by researchers specific to the training needs and do not appear to be validated. Only a small number of studies (nine of 30) used previously validated instruments—such as the DKT, DAS, DCS, DKQ, CHDKT, and the SOFIT–X. However, the target population in the validation studies of these six instruments were either patients, health care providers, or the general public. None of these validated instruments were comprehensive, comprising only one to three of the seven MRFs.

Consistent with previous literature, this review highlights the fact that while CHWs are trained on the same level as other health paraprofessionals, their training and assessment methods are far from meeting clinical standards. We identified the following critical gaps: 1) lack of uniformity in training curriculum for CHWs in stroke and CVD and prevention 2) absence of rigorous CHW–specific competency assessment methods 3) limited use of validated tools to assess CHW competencies, and 4) inconsistencies in reporting assessment methods.

This study has several limitations. First, this review only includes studies that were published in the literature. Given the diversity of the CHW field, it is possible to have missed assessment methods included in gray literature or academic reports. Second, only articles published in English were included, therefore limiting the search for assessment methods existent in non–English languages. Third, since a scoping review was conducted, no statistical methods were used, therefore causal relationships between assessment methods and performance outcomes could not be commented on.

However, this scoping review had several strengths: 1) the comprehensive search criteria yielded a considerable number of articles that trained CHWs in the risk factors for stroke, 2) the existence of wide–ranging curricula in stroke prevention tailored to train CHWs and lay health workers were identified, 3) this is the first review to synthesize assessment methods to measure CHW competencies. Therefore, these findings validate the results of other studies that underscore the need for standardized and validated assessment tools to measure CHW competencies (Kok et al., 2017).

Conclusion

In order for national and private health initiatives to function properly and produce measurable results, well–trained employees are the key to success. Competency assessments for educational evaluation are an imperative in preparing professionals like physicians, nurses, medical paraprofessionals, and trainees in the CHES/MCHES programs. Robust education competency assessments serve as a "quality assurance mechanism," ensuring that all health professionals have the same knowledge and skill set—psychometric evaluations of the quality of educational outcome measures are an important first step in conducting this type of evaluative inquiry.

Currently, there are no developmentally informative or psychometrically validated instruments for assessing CHW disease–specific knowledge and skills and behavior. For CHWs who learn and practically apply complex medical concepts, measuring core competencies alone is no longer sufficient.

There is ample evidence of CHWs leading increasingly complex health care activities (Viswanathan et al., 2009; WHO, 2018) including COVID–19 response (Mayfield–Johnson et al., 2020). If CHWs are to be recognized as an essential healthcare workforce and integrated into the healthcare systems, strengthening the way they are trained and assessed will have to be prioritized. Having identified critical gaps in this area through this scoping review, it can be concluded that there is an urgent need for development of a comprehensive and valid assessment instrument in stroke prevention to assess CHW performance to deem them 'deployment ready' for fieldwork.

CHAPTER III

DEVELOPMENT AND VALIDATION OF A STROKE LITERACY ASSESSMENT TEST FOR COMMUNITY HEALTH WORKERS

Introduction

Stroke is a major contributor to chronic disease burden in the United States (CDC, 2021). Nearly 4% of US adults will have had a stroke by 2030, accounting for increasing medical costs from $71.55 billion in 2012 to $183.13 billion by 2030 (Ovbiagele et al., 2013). Its prevalence remained at 2.7%, without significant change between 2006 and 2010. Although an overall 2.3% decline in stroke mortality took place during this period, it was not proportionate across populations (Furie, 2020).

Despite such trends in prevalence and mortality, 90% of all strokes remain preventable and can be attributed to modifiable risk factors (MRF) (Hankey, 2020). The seven key MRFs in stroke prevention include: high blood pressure (BP), high cholesterol, diabetes mellitus (DM), smoking, obesity, unhealthy diet, and physical inactivity (Diener & Hankey, 2020). Primary stroke prevention aims to target risk factor modification and adoption of healthy lifestyle behaviors like healthy eating, regular PA, and abstaining from smoking (Boehme et al., 2017; Weintraub et al., 2011). The burden of stroke attributable to MRFs underscores the need for a combination of high–risk and population–wide strategies for education about stroke risk factors and adoption of healthy lifestyle behaviors (Hankey, 2020; WHO, 2018).

To this end, the current WHO guidelines recommend devoting resources in community–based prevention measures—namely CHW–led interventions to tackle this growing problem (WHO, 2018). Research has shown that community–based stroke interventions delivered by adequately trained community health workers (CHW) are highly effective in stroke risk factor education and management (Brownstein et al., 2005).

However, to determine whether a CHW has received adequate training to deliver stroke prevention interventions, training expectations and assessments need to be determined at the outset of training. This establishes the knowledge and skills required to be a competent community health worker and prepares them adequately for fieldwork.

Community Health Worker Competency Assessments in Stroke Prevention

Current literature on the stroke training programs for CHWs rarely report how they are assessed for competencies. A few studies that described the assessment methods, mostly derived the assessments from the training curriculum or researchers independently developed them specific to the training needs and do not appear to be validated. Only a small number of studies used previously validated instruments—the Diabetes Knowledge Test (DKT) (Colleran et al., 2012; Han et al., 2007; Look et al., 2008; Policicchio & Dontje, 2018; Tang et al., 2011; Vaughan et al., 2020); Diabetes Knowledge Scale (DKS) (Colleran et al., 2012; Look et al., 2008; Policicchio & Dontje, 2018; Zurawski et al., 2016); Diabetes Knowledge Questionnaire (DKQ) (Tang et al., 2011); Coronary Heart Disease Knowledge Test (Moleta et al., 2017); and System for Observing Fitness Instruction Time for Group Exercise Classes (SOFIT–X) (Haughton et al., 2015). Of these, three instruments measured the cognitive domain (DKT, DKQ, CHDKT), two measured the affective domain (DAS, DCS), and only one measured skills or psychomotor domain (SOFIT–X). However, all these instruments were specific to a single risk factor, such as diabetes, and did not encompass components of all the seven MRFs. Neither were they developed specifically for the CHW population.

Existing Stroke Literacy Instruments

A review of literature was conducted to explore existing validated stroke literacy tools, pertaining to the seven MRFs. The search revealed three instruments that included stroke risk factors. Sullivan and Dunton's (2004) stroke knowledge test (SKT), a validated instrument on basic knowledge of stroke, its risk factors and warning signs that are culturally tailored for Australian adults. This 20–item instrument with multiple–choice questions has nine questions focused on risk factors (Sullivan & Dunton, 2004). The stroke recognition questionnaire (SRQ) developed by Ennen and Zerwic (2010) is a four–part questionnaire 1) 20 items on stroke symptoms, 2) 20 items on stroke risk factors, 3) four items on recognition of stroke, and 4) demographics. The instrument was designed with a yes versus no format for responses and was developed to assess stroke knowledge among rural and non–rural residents in six East Central Illinois (Ennen & Zerwic, 2010). Another instrument on stroke risk factors was the stroke awareness questionnaire (SAQ) developed by Hickey and coauthors (2012) for adult populations in Ireland. The SAQ is a five–part questionnaire and includes questions on stroke risk factors and warning signs (Hickey et al., 2012).

Other validated instruments on individual MRFs of stroke were also identified. Schapira et al.'s Hypertension Evaluation Lifestyle and Management (HELM) is a 14–item knowledge scale that measures general hypertension knowledge, lifestyle and medication management, and measurement and treatment goals. This validated instrument is designed using the multiple–choice question format with one possible correct answer (Schapira et al., 2012). The revised brief diabetes knowledge test (DKT2) is a validated instrument with 14 items on diabetes knowledge and nine items on insulin knowledge (Fitzgerald et al., 2016). Another validated tool on a modifiable risk factors is the revised general nutrition knowledge questionnaire (GNKQ) developed for adult UK population (Kliemann et al., 2016). This 88–item instrument assesses knowledge on dietary recommendations, food groups, diet, disease, and weight management. Owing to the common risk factors of stroke and heart disease, the coronary heart disease (CHD) knowledge tool (Thanavaro et al., 2010) and the heart disease knowledge questionnaire (HDKQ) (Bergman et al., 2011) are other relevant validated instruments with risk factors questions.

The SKT, SRQ, and SAQ instruments had a number of questions on stroke risk factors, but none were exclusively developed to assess knowledge on stroke risk factors and prevention measures. In addition, the SKT and the SAQ which were developed for populations in Australia and Ireland respectively may not be replicable to CHWs in the United States. Similarly, the HELM, DKT2, GKNQ, CHD, nor HDKQ encompass all the seven MRFs identified as key in prevention of stroke. Furthermore, none of these instruments report the use of a formal assessment design approach, nor taxonomic classification in developing learning outcomes.

The scoping review of CHW literature on competency assessment methods (Chapter II) and a review of other existing stroke literacy instruments underscores that: 1) there were few or no domain–referenced tests/instruments of knowledge on stroke risk factors and prevention for CHW preparation programs and populations, a major gap in the practice–based community healthcare literature; 2) no comprehensively conducted design–validation studies of available assessments that comply with the most current AERA, APA & NCME (2014) standards exist. This evidence supports the critical need for development of a validated instrument to evaluate CHWs in stroke risk factor and prevention knowledge.

The purpose of this study was to develop a valid and reliable instrument to assess CHWs in the seven MRFs for stroke. This chapter reports the design of the stroke literacy assessment test (SLAT) using a systematic methodology guided by the *process model* for assessment design and the *functional taxonomy* (Chatterji, 2003).

Approaches to Instrument Validity

The *Standards for Educational and Psychological Testing* jointly sponsored by the American Educational Research Association (AERA), the American Psychological Association (APA), and the National Council on Measurement in Education (NCME) are a set of professional standards for sound development of educational and psychological testing practices and evaluating the quality of those practices (AERA, APA, NCME, 2014).

According to these standards, a well–designed test produces scores that accurately classify the individuals being measured on a specified construct domain, with no biases (Chatterji, 2003, p. 57). As a result, before tests are used in formal contexts, they must be thoroughly evaluated (Wyer & Chatterji, 2013). The procedures employed to ensure that an assessment tool yields valid results are collectively called a validation process (Chatterji, 2003, p. 57). According to Lee Cronbach (1971), multiple methods of validity evidence must be gathered for comprehensive evaluation of a test (Cronbach, 1971, p. 445). Cronbach (1971) also recommends that the validation processes be theory driven and supported by hypotheses on how the construct measures perform in empirical tryouts. A sound validation process integrates various strands of evidence with existing evidence and theory supporting the test and its specific uses (AERA, APA, NCME, 2014).

According to the *Standards for Educational and Psychological* Testing—Validity is therefore, the most fundamental consideration in developing and evaluating tests (AERA, APA, NCME, 2014). The validity of a test can be evaluated using various sources of evidence that highlight different aspects of validity, namely: evidence based on test content, evidence based on response processes, evidence based on internal structure, and evidence based on relation to other variables. Ultimately, the validity of an intended interpretation of test scores relies on all available evidence relevant to the technical quality of a testing system.

Additionally, reliability—defined as the consistency of stability of test results under different conditions—is also an essential criterion for measuring measurement quality. It can therefore be conceptualized as a component of validity, and determined through repeated measurement among groups or individuals (AERA, APA, & NCME, 2014). Assuming that an assessment is valid, there is still a likelihood that a test performance could vary across several occasions caused by random factors—known as *random error* (Chatterji, 2003, p. 67). Even in assessments designed to provide maximum possible levels of validity, random error can account for some degree of unreliability (Chatterji, 2003).

In this chapter, the methods using the Process Model in planning and defining context specifications (Phase I), specification of construct domain (Phase II), development of the instrument (Phase III), and content validation by expert reviews (Phase IVA) for the SLAT are described in detail.

Theoretical Framework

The conceptual framework for this study and development of the instrument were based on two models: the *Process Model for Assessment Design, Validation, and Use* (Chatterji, 2003, pp. 104–110) the *Functional Taxonomy* (Chatterji, 2003, pp. 139–140), described in detail in Chapter II.

This study is centered around the *process model* for assessment design and validation, an approach developed by Chatterji (2003). This context–based model provides a design framework with four essential phases, Phases I–IV (Chatterji, 2003, pp. 105–110). In this study, a unified approach to construct validation of the "stroke literacy" construct supported by literature was used. The model stipulates a cyclic process involving planning and defining context specifications (Phase I), specification of construct domain (Phase II), development of the instrument (Phase III), content validation by expert reviews (Phase IVA) and empirical validation (Phase IVB). Each phase of the model allows for iterative cycles of validation and refinement until a desired quality for the test is achieved. Figure 3.1 illustrates use of the *process model* in the development of the stroke literacy assessment test (SLAT) (Chatterji et al., 2002; Chatterji, 2003).

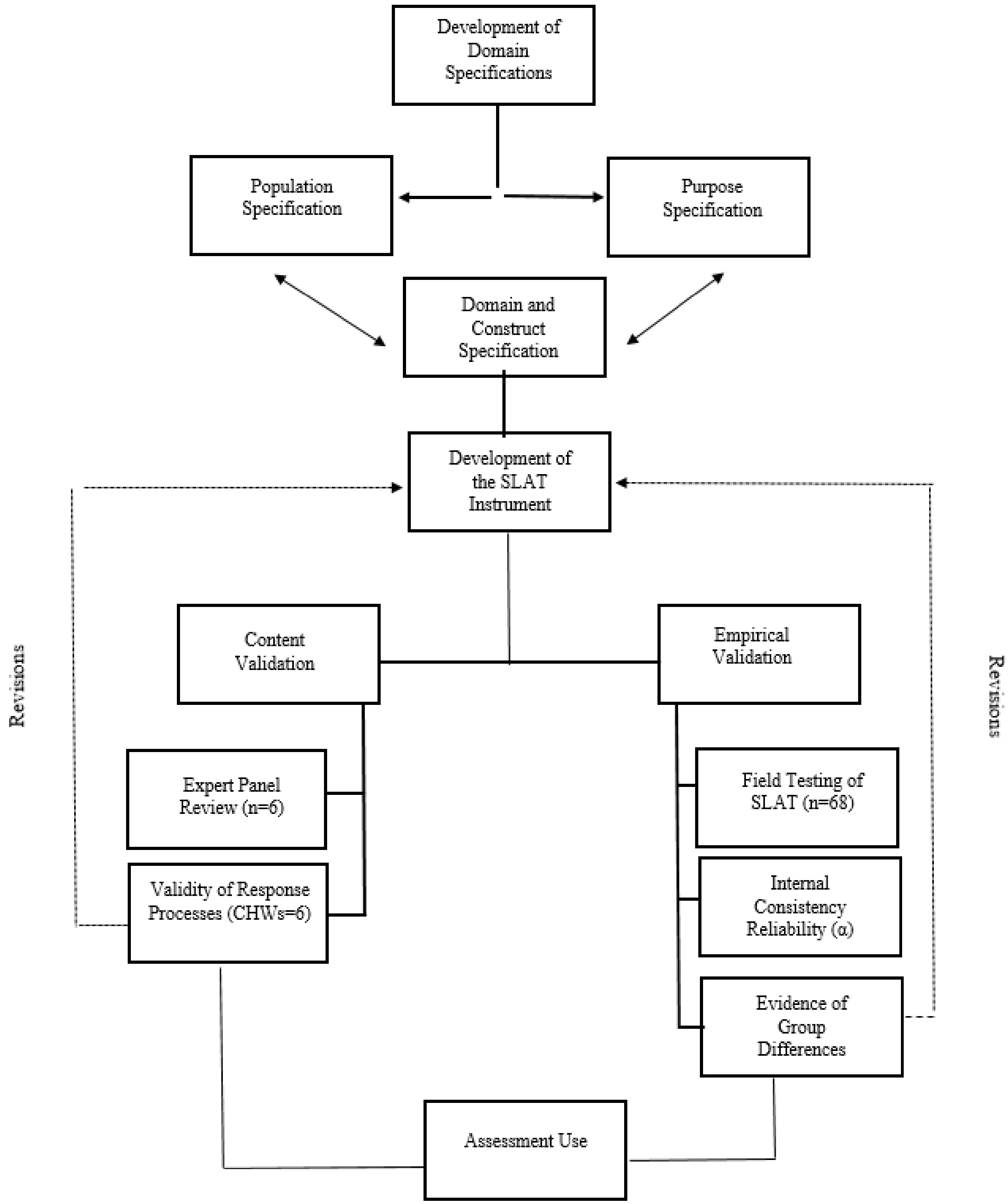

Figure 3.1. Process Model for Development of SLAT (adapted from Chatterji, 2003)

Methods

The development of the SLAT was informed by an initial pilot instrument that was created with the domain "stroke literacy" and three sub–domains: stroke knowledge, stroke risk factors, and stroke preparedness. Findings from the pilot instrument and consultations with experts, led to the design of the revised "stroke literacy" domain pertaining to the seven modifiable risk factors for stroke (hypertension, smoking, high blood cholesterol, diabetes, physical inactivity, obesity, and diet) (Boehme et al., 2017; Virani et al., 2020). A decision was made to prioritize on the stroke risk factors instrument for this specific population where there is a clear gap in the literature.

The objective of this study was to develop a stroke literacy assessment test (SLAT) (pertaining to the seven MRFs for stroke) for evaluation of CHW competencies and to examine validity and reliability of the construct measures through content validation and empirical tryouts.

The following section describes the development and validation of the SLAT using the Process Model for Assessment Design and Use in four phases (Phase I–IV) (Figure 3.1) (Chatterji, 2003).

Phase I: Specification of Assessment Context

Applying the Process Model for Assessment Design/Selection (Phase I) (Chatterji, 2003) a thorough literature review was conducted to develop the domain specification for the SLAT including the purpose, population, construct to be measured, assessment uses, assessment users, and scoring methods. The cognitive domain for this instrument was "stroke literacy" (SL) defined as knowledge of prevention measures of the seven MRFs for stroke (Willey et al., 2009; Virani et al., 2020). Keeping the target population in mind, relevant literature was reviewed to define boundaries for the domain (Abdel–All et al., 2017). The SL construct for the SLAT was developed through consultations with stroke neurologists, community health education specialists, measurement experts, and experienced community health workers. In writing the learning competencies, the *functional taxonomy* developed by Chatterji (2003) was used as a cognitive taxonomic tool to classify the different levels of cognitive competence of CHWs in stroke risk factors and prevention measures (Chatterji, 2003; Chatterji et al., 2009). For the purpose of the SLAT, learning outcomes recognizing the following levels of cognition were developed:

- Factual knowledge and understanding: demonstration of basic knowledge of the seven key modifiable risk factors for stroke such as facts, definitions, terms, understanding of prevention and control measures.
- Application: skills of stroke risk factor concepts and prevention guidelines in performing a task or making a clinical inference.

Table 4.1 illustrates the assessment specifications for the SLAT.

The purpose of the SLAT is to evaluate the baseline and post–training knowledge of CHWs' in a stroke prevention training program. Specifically, the SLAT will determine the competence of CHWs' knowledge in the seven MRFs and prevention measures for stroke. Measuring the CHW competence is essential for determining the ability and readiness of the CHWs to provide quality services in the field. Further, it can determine the efficacy of the training program in closing knowledge and skill gaps and improve training. Low scores on competence assessments after training may indicate that the training was ineffective, poorly designed, poorly presented, or inappropriate (Kak et al., 2001).

The population targeted for using the SLAT are CHWs receiving the eight–week InTOuCH stroke prevention training program at Columbia University described in chapter I. The InTOuCH CHWs are predominantly African Americans from West and Central Harlem in New York City. The SLAT is intended for use as an Individual Assessment Written Structured Response (W–SR). Community health educators are the intended administrators of the instrument.

The W–SR test includes multiple choice questions (MCQ), true/false (T/F), and matching exercises with answer key, each item worth one point (Table 3.1). W–SR were used to design the test items to tap into two cognitive levels: factual knowledge and application. Majority of the questions were MCQ and its variations. This format was chosen as it is known to produce high reliability and usability across multiple taxonomic levels, and it also reduces the chances of the test taker guessing the correct answer (Chatterji, 2003, p. 191).

Table 3.1. SLAT Assessment Specifications

Assessment Purpose: To evaluate stroke literacy (knowledge of stroke risk factors and prevention measures) in trained adult community health workers (Willey et al., 2009). **Population:** Upcoming cohorts of community health workers of Columbia's InTOuCH Stroke Prevention Training Program. **Construct:** Stroke Literacy in CHWs as it pertains to stroke risk factors and prevention measures, specifically the seven modifiable risk factors (hypertension, smoking, high blood cholesterol, diabetes, physical inactivity, obesity, and diet) (Boehme et al., 2017; Virani et al., 2020). **Assessment Uses:** ● Classroom assessment of upcoming cohorts of CHWs in training contexts ● Program Evaluation **Assessment Users:** ● Program Managers for summative–decision making ● Community–based researchers in stroke prevention studies **Assessment Methods** • All Competencies: Written, Structured Response Test (W–SR) • Individual/Group Assessment: Individual Assessment • Who Assesses: Community Health Educator **Scoring Method:** Multiple Choice Questions (MCQ), True/False (T/F), and Matching Exercises with Answer key

Phase II: Specification of Construct Domain

The construct domain identified for the SLAT is "stroke literacy" (SL) in CHWs as it pertains to the seven MRFs for stroke. The domain specification was informed by in–depth literature review, and consultation with experts in stroke and community health education specialist with insights on the target population. The SLAT is designed to capture knowledge of CHWs in the seven MRFs. Modification of these key risk factors is recognized as the goal to achieve ideal cardiovascular health (Virani et al., 2020). Following the specification of the "stroke literacy" domain, clear and explicit general and specific indicators for each of the seven risk factors was formulated. The general indicator of the instrument is specified for competent CHWs to demonstrate knowledge of the seven modifiable risk factors and prevention measures of stroke (hypertension, smoking, high blood cholesterol, diabetes, physical inactivity, obesity, and diet). Further, clear and observable specific indicators for each of the risk factors were formulated (Appendix A).

The draft written structured response (W–SR) test yielded 72 items. The questions were drafted by each risk factor to capture the following: 1) hypertension—knowledge of hypertension and how to prevent it, 2) smoking—knowledge of risk of smoking and how to prevent it, 3) high blood cholesterol—knowledge of high blood cholesterol and how to prevent it, 4) diabetes—knowledge of diabetes and how to prevent it, 5) physical inactivity—knowledge of physical activity and its benefits, 6) obesity—knowledge of obesity and importance of weight control, and 7) diet—knowledge of diet and benefits of healthy eating.

Phase III: Item Pool Generation

Items were generated from literature retrieved from two databases—PubMed and HaPI, and the Centers for Disease Control (CDC) CHW Training Resource for Preventing Heart Disease and Stroke (CDC, 2015). Due to limited literature on validated instruments on knowledge of stroke risk factors and prevention, items were generated from previously validated instruments with knowledge questions on stroke and or any of the seven modifiable risk factors of stroke: 1) the stroke knowledge test (SKT) developed for Australian adults (Cronbach's α=.7) (Sullivan & Dunton, 2004), 2) Schapira et al's Hypertension Evaluation Lifestyle and Management (HELM) scale that measures general hypertension knowledge, lifestyle and medication management, and treatment goals (Schapira et al., 2012), 3) the revised brief diabetes knowledge test (DKT2) items on diabetes and insulin knowledge (Cronbach's α=.77) (Fitzgerald et al., 2016), 4) the revised general nutrition knowledge questionnaire (GNKQ) developed for adult UK population (Cronbach's α >.7) (Kliemann et al., 2016), and 5) the physical literacy knowledge questionnaire (PLKQ) developed for Canadian children (Longmuir et al., 2018).

These sources were used to guide item writing for the SLAT in a W–SR format (multiple choice questions, true/false, and matching exercises) reflecting the scope of the construct domain, ensuring that all areas of the table of specifications were represented appropriately.

To begin, a pool of items was selected and matched against domain specifications. Approximately 40% of the items met the cognitive level of taxonomy. Items that did not meet the guidelines for structured item formats were revised and reordered to align with the taxonomic levels of the indicators—factual knowledge, understanding, and application. The items identified as "poorly constructed" were further modified to design "cognitively–informed" questions with plausible response options to satisfactorily match indicators and learning competencies

(Chatterji, in press/in publication, p.7–12). At least one item per competency, consisting of a stem, one correct answer, and three distractors, was developed. In addition, new questions were written to ensure that the test had more items than needed for field testing.

This initial SLAT had 72 questions in W–SR format. The multiple choice items, most widely used in assessment tests includes a question stem with three to five answer responses—with only one best or correct answer. The incorrect options are called *distracters or foils*, which are meant to distract the uninformed student from the correct answer.

The SLAT had 27 MCQs with four response options and *context–dependent items* which requires the test taker to read a scenario, chart, and or graph to determine the correct response using the provided information. In the SLAT these included interpretation of a cholesterol lab report (Q11–Q13), a BMI chart (Q29–Q30), a nutrition facts label (Q34–Q35, Q39), and the USDA's MyPlate figure (Q38) by determining the correct response using the provided information. Matching exercises (items 25–27 and items 41–46) were included to measure the taxonomic level '*factual knowledge'* of students. Both the question stems 25–27 and 41–46 were required to match definitions in column A to their appropriate terms in column B. The true/false is another W–SR format to typically test the factual knowledge of the test taker, and uses propositional statements that one must affirm or negate. Ten true/false items were clustered in the SLAT instrument.

Items were then assimilated into a usable form for content validation by expert reviewers, and validation of response processes using cognitive interviews in a purposive sample of the target population described in the next section.

Phase IV: Validation of the SLAT

Content Validation by Expert Reviews.

Assessment of content validity was conducted to determine the content relevance, clarity and conciseness for each item and the overall instrument by six expert reviewers. The reviewers with expertise on the content and domain areas of the instrument were selected to validate the items. The experts in the panel consisted of five stroke neurologists, and one anesthesiologist who also had experience in measurement, and community health education. The earlier iteration of the instrument was reviewed for construct specification and item writing by a psychometrician.

The refined items arranged in a suitable sequence in a content validation checklist was provided to the experts with specific instructions by which to determine the content validity for each item and the instrument.

The experts were provided:

- a letter explaining the study and their role as experts reviewing the instrument for the purposes of content validation
- the construct domain specifications and competencies of the SLAT instrument
- the draft questions (72–items) with an item validation checklist and instructions

It was established that four experts must agree for the items and total instrument to be assessed and established for content validity (Lynn, 1986). Experts were provided with the full content domain for the knowledge domain (cognitive) with specific instructions to determine the content relevance, clarity and conciseness for each item.

Evidence Based on Response Processes.

Evidence based on response processes generally comes from questioning groups making up the intended test–taking population (AERA, APA, NCME, 2014). Following the instrument modification, cognitive testing of the response processes was conducted on a purposively selected sample of six community health workers. The test was shared with the participants who were interviewed by the author using a think–aloud method to uncover the cognitive processes that occur during test taking. The test was used specifically to clarify comprehensibility and response format. Other aspects of performance such as response time and the ease of test taking on the online platform—Qualtrics was recorded. The interviews were audiotaped and the interviewer also took brief notes. The interviews were transcribed verbatim and coded by hand. The interviewer's notes were examined for details on accuracy and completeness. Recurring patterns in the data were identified and categorized into four key themes: 1) Confusing questions, 2) Confusing response options, 3) Variable interpretation of terms, and 4) Inadequate instructions (Carbone et al., 2002).

Results

Content Validation

Content Validity Index (CVI) was derived for content relevance, clarity and conciseness of the instrument using a four–point ordinal rating scale, where 1 connoted an irrelevant item and 4 an extremely relevant item. To calculate the proportion in agreement about relevance for each item, the I–CVI was computed as the number of experts giving a rating of either 3 or 4, divided by the number of experts (Polit, Beck, & Owen, 2007).

The CVI for the entire instrument is the proportion of the total items judged as valid for content. In addition to judging each item, experts provided qualitative feedback on areas that had to be revised and/omitted from the instrument.

All six raters either agreed or strongly agreed that the construct, domains and indicators were appropriate to use with this population (Community Health Workers). However, experts had suggestions for several items with comments, that were incorporated as revisions to the instrument.

Item 3: "There are meds that modify risk for future MI and stroke that could be correct for these response options"

Item 6: "Question is still too confusing, split into two questions"

Item 8: "Why not mention specific foods instead in the response options?"

Items with I–CVI of 0.83 or greater were retained in the instrument. Individual items that received ratings < 0.67 were dropped from the test, whereas items with CVI=0.67 were tweaked based on the qualitative feedback from experts to assimilate the final instrument. For the scale validity, the lower limit of acceptability was set at 0.8. The S–CVI for this instrument met the acceptability standards for relevance, clarity and conciseness (Polit et al., 2007) (Lynn, 1986). Overall, the average ratings for the scale (S–CVI) were 0.9, 0.82, and 0.85 for content relevance, clarity, and conciseness respectively, which was acceptable as per criterion for 6 experts' reviewers (Polit et al., 2007) (Tables 3.2, 3.3 & 3.4).

Items that performed poorly and deemed not relevant were removed after two rounds of content validation, resulting in a 46–item test. This version was validated for response processes by a purposive sample of CHWs.

Content Relevance.

The average S–CVI for clarity of all items was 0.90. I–CVIs for items 23, 25, 27, 41, 59, 65, and 68 were 0.67 or lesser. Rating on a 72–Item Scale by Six Experts: Items rated 3 or 4 on a Four–Point Clarity Scale (Table 3.2).

Table 3.2. Expert Review: Content Relevance

Relevance: 1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
1	4	4	4	4	4	4	6	1.00
2	4	4	4	4	4	4	6	1.00
3	4	3	3	3	1	4	5	0.83
4	4	2	3	4	4	4	5	0.83
5	4	4	4	2	4	4	5	0.83
6	4	4	3	3	3	4	6	1.00
7	4	4	4	4	4	4	6	1.00
8	4	4	3	3	4	4	6	1.00
9	4	4	4	4	4	4	6	1.00
10	4	3	3	4	4	3	6	1.00
11	4	4	4	4	4	4	6	1.00
12	4	2	3	3	4	4	5	0.83
13	4	4	4	4	4	4	6	1.00
14	4	4	4	4	4	4	6	1.00
15	4	4	3	4	4	3	6	1.00
16	4	1	3	4	4	4	5	0.83
17	4	4	4	4	4	4	6	1.00
18	4	4	3	4	4	4	6	1.00
19	4	4	3	4	4	4	6	1.00
20	4	4	4	4	4	4	6	1.00
21	4	4	4	4	4	4	6	1.00
22	4	4	4	3	4	4	6	1.00
23	4	4	4	3	2	2	4	0.67
24	4	4	3	3	4	3	6	1.00
25	4	1	3	3	2	2	3	0.50
26	4	4	3	3	4	3	6	1.00

Relevance: 1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
27	2	2	2	3	2	2	1	0.16
28	4	4	3	2	4	4	5	0.83
29	4	3	3	3	3	3	6	1.00
30	4	3	4	3	4	3	6	1.00
31	4	4	4	4	4	4	6	1.00
32	4	4	4	4	4	3	6	1.00
33	3	4	1	4	4	4	5	0.83
34	4	4	3	4	4	4	6	1.00
35	4	4	1	3	4	3	5	0.83
36	4	4	4	4	4	3	6	1.00
37	4	2	4	3	4	4	5	0.83
38	4	3	4	3	4	4	6	1.00
39	4	4	4	4	4	4	6	1.00
40	4	2	3	4	4	4	5	0.83
41	2	2	2	4	2	2	1	0.16
42	4	4	4	4	4	4	6	1.00
43	4	4	4	3	4	4	6	1.00
44	4	4	2	4	4	4	5	0.83
45	4	3	3	2	2	4	5	0.83
46	4	2	4	3	4	4	5	0.83
47	4	4	4	4	4	4	6	1.00
48	4	4	2	4	4	4	5	0.83
49	4	4	3	4	4	4	6	1.00
50	4	4	4	4	4	4	6	1.00
51	3	4	3	3	4	4	6	1.00
52	4	4	3	3	4	4	6	1.00
53	4	4	2	4	4	4	5	0.83
54	4	4	4	4	4	4	6	1.00
55	4	4	4	4	4	4	6	1.00
56	4	4	4	3	4	4	6	1.00
57	4	4	3	3	4	4	6	1.00
58	4	4	4	3	4	3	6	1.00
59	3	2	1	2	2	4	2	0.33
60	4	4	4	4	4	4	6	1.00
61	4	4	4	4	4	4	6	1.00
62	4	4	4	4	4	3	6	1.00

Relevance: 1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
64	4	4	3	4	4	3	6	1.00
65	3	4	2	4	2	4	4	0.67
66	4	4	4	4	4	4	6	1.00
67	4	4	2	4	3	4	5	0.83
68	4	3	1	2	2	4	3	0.50
69	4	4	4	4	4	4	6	1.00
70	4	4	4	4	4	4	6	1.00
71	4	4	3	4	3	4	6	1.00
72	4	4	4	4	4	4	6	1.00
Proportion Relevant Average CVI								**0.90**

Item Clarity.

The average S–CVI for clarity of all items was 0.82. I–CVIs for items 4, 7, 10, 18, 21, 26, 27, 28, 31, 32, 33, 34, 41, 48, 49, 50, 53, 56, and 63 were 0.67 or lesser. Rating on a 72–Item Scale by Six Experts: Items rated 3 or 4 on a Four–Point Clarity Scale (Table 3.3).

Table 3.3. Expert Review: Item Clarity

Clarity: 1=not clear, 2=item needs some revision, 3=clear but needs minor revision, 4=very clear								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
1	4	4	3	4	4	3	6	1.00
2	4	4	4	4	4	4	6	1.00
3	3	4	2	1	1	3	3	0.50
4	4	4	3	2	3	4	5	0.83
5	3	4	4	2	4	4	5	0.83
6	3	4	2	2	3	4	4	0.67
7	4	4	4	2	4	4	5	0.83
8	3	4	3	1	4	3	5	0.83
9	4	4	2	2	4	4	4	0.67
10	4	2	4	2	4	2	3	0.50
11	4	4	4	4	3	4	6	1.00
12	4	4	4	3	4	3	6	1.00
13	4	2	3	4	4	4	5	0.83
14	4	3	3	4	4	4	6	1.00
15	4	3	3	2	4	3	5	0.83
16	4	4	2	4	4	4	5	0.83
17	4	4	4	4	4	4	5	0.83
18	4	4	2	1	4	4	4	0.67
19	4	4	2	4	4	4	5	0.83
20	4	4	2	3	4	4	5	0.83
21	3	1	3	3	4	2	4	0.67
22	4	4	3	3	3	3	6	1.00
23	4	4	4	3	4	3	6	1.00
24	4	4	3	2	4	3	5	0.83
25	4	4	2	1	1	1	2	0.33
26	3	4	2	1	4	3	4	0.67

Clarity: 1=not clear, 2=item needs some revision, 3=clear but needs minor revision, 4=very clear								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
27	4	3	1	2	3	3	4	0.67
28	4	4	3	2	2	4	4	0.67
29	4	3	3	2	3	4	5	0.83
30	4	4	3	3	4	4	6	1.00
31	4	4	4	1	2	2	3	0.50
32	2	4	4	1	3	3	4	0.67
33	4	4	2	2	4	4	4	0.67
34	4	4	1	2	4	4	4	0.67
35	4	4	2	3	4	4	5	0.83
36	4	4	3	2	4	3	5	0.83
37	4	4	3	3	4	4	6	1.00
38	4	4	4	2	4	4	5	0.83
39	4	4	4	2	4	3	5	0.83
40	4	4	3	2	4	3	5	0.83
41	2	3	2	1	2	2	1	0.16
42	4	4	3	1	4	4	5	0.83
43	4	4	4	1	3	4	5	0.83
44	4	4	3	4	4	4	6	1.00
45	4	4	1	4	3	3	5	0.83
46	4	4	4	2	3	4	5	0.83
47	4	4	3	3	3	3	6	1.00
48	3	3	1	2	4	4	4	0.67
49	3	4	2	2	2	2	3	0.50
50	4	4	2	2	4	4	4	0.67
51	4	4	3	1	3	3	5	0.83
52	4	4	3	3	4	4	6	1.00
53	4	4	2	1	4	4	4	0.67
54	4	4	4	3	4	4	6	1.00
55	4	4	4	4	4	3	6	1.00
56	4	4	3	2	2	3	4	0.67
57	4	4	3	3	3	4	6	1.00
58	4	4	4	3	4	4	6	1.00
59	4	4	4	3	4	4	6	1.00
60	4	4	4	4	4	4	6	1.00
61	4	4	4	4	4	4	6	1.00

Clarity: 1=not clear, 2=item needs some revision, 3=clear but needs minor revision, 4=very clear								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
62	4	4	4	4	4	2	5	0.83
63	4	4	4	2	2	3	4	0.67
64	3	4	3	4	4	3	6	1.00
65	4	4	3	4	3	4	6	1.00
66	4	4	4	2	4	4	5	0.83
67	4	4	4	4	4	3	6	1.00
68	4	4	3	2	3	3	5	0.83
69	3	4	4	2	4	4	5	0.83
70	4	4	4	2	4	4	5	0.83
71	4	4	4	4	4	4	6	1.00
72	4	4	4	4	4	4	6	1.00
Proportion Relevant Average CVI								**0.82**

Conciseness.

The average S–CVI for the conciseness of all items was 0.85. I–CVIs for items 3, 5, 6, 8, 10, 18, 24, 26, 34, 48, 49, 51, 53 and 56 were 0.67 or lesser. Rating on a 72–Item Scale by Six Experts: Items rated 3 or 4 on a Four–Point Conciseness Scale (See Table 3.4).

Table 3.4. Expert Review: Conciseness

Conciseness: 1=not concise, 2=item needs some revision, 3=concise but needs minor revision, 4=very concise								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
1	4	3	3	4	4	4	6	1.00
2	4	4	3	4	4	4	6	1.00
3	4	4	2	1	1	3	3	0.50
4	4	4	3	2	4	4	5	0.83
5	3	4	2	1	4	4	4	0.67
6	3	4	2	1	3	3	4	0.67
7	4	4	4	2	4	4	5	0.83
8	3	4	2	1	2	4	3	0.50
9	4	4	3	3	4	4	6	1.00
10	4	4	4	2	4	2	4	0.67
11	4	4	4	4	4	3	6	1.00
12	4	4	4	3	3	3	6	1.00
13	4	4	3	1	3	3	5	0.83
14	4	1	4	4	4	4	5	0.83
15	4	4	3	2	4	4	5	0.83
16	4	4	2	4	4	4	5	0.83
17	4	4	4	4	4	4	6	1.00
18	4	4	2	1	4	4	4	0.67
19	4	4	4	4	4	4	6	1.00
20	4	3	3	3	4	4	6	1.00
21	3	3	4	3	4	4	6	1.00
22	4	4	2	4	4	4	5	0.83
23	4	4	4	4	4	4	6	1.00
24	4	4	2	2	4	4	4	0.67
25	4	4	3	1	4	4	5	0.83
26	4	4	2	1	4	3	4	0.67
27	4	4	3	2	4	3	5	0.83

Conciseness: 1=not concise, 2=item needs some revision, 3=concise but needs minor revision, 4=very concise								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
28	4	4	3	2	4	4	5	0.83
29	4	4	3	2	4	4	5	0.83
30	4	4	4	3	4	4	6	1.00
31	4	4	4	1	3	3	5	0.83
32	4	4	4	1	4	4	5	0.83
33	4	4	3	2	4	4	5	0.83
34	4	4	2	2	4	4	4	0.67
35	4	4	3	3	4	4	6	1.00
36	4	4	3	2	4	4	5	0.83
37	4	3	3	3	4	4	6	1.00
38	4	4	4	2	4	4	5	0.83
39	4	4	4	2	4	3	5	0.83
40	4	4	3	2	4	4	5	0.83
41	4	3	2	1	2	2	2	0.33
42	4	4	4	1	4	4	5	0.83
43	4	4	4	1	4	4	5	0.83
44	4	4	2	4	4	4	5	0.83
45	4	4	2	4	4	4	5	0.83
46	4	4	4	2	4	4	5	0.83
47	4	4	3	4	4	4	6	1.00
48	3	4	2	2	4	4	4	0.67
49	3	4	2	2	3	3	4	0.67
50	4	4	3	2	4	4	5	0.83
51	4	4	1	1	4	4	4	0.67
52	4	4	3	3	4	4	6	1.00
53	4	4	1	1	4	4	4	0.67
54	4	4	4	3	4	4	6	1.00
55	4	4	4	4	4	4	6	1.00
56	4	4	2	2	4	4	4	0.67
57	4	4	2	3	4	4	5	0.83
58	4	4	4	3	4	4	6	1.00
59	4	4	4	3	4	4	6	1.00
60	4	4	4	4	4	4	6	1.00
61	4	4	4	4	4	4	6	1.00
62	4	4	4	4	4	4	6	1.00
63	4	4	4	2	4	4	5	0.83

Conciseness: 1=not concise, 2=item needs some revision, 3=concise but needs minor revision, 4=very concise								
Items	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**	**Experts in Agreement**	**Item CVI**
64	4	4	3	4	4	4	6	1.00
65	4	4	2	4	3	3	5	0.83
66	4	4	4	2	4	4	5	0.83
67	4	4	4	4	4	4	6	1.00
68	4	4	3	2	4	4	5	0.83
69	4	4	3	2	4	4	5	0.83
70	4	4	4	2	4	4	5	0.83
71	4	4	4	4	4	4	6	1.00
72	4	4	4	4	4	4	6	1.00
Proportion Relevant Average CVI								**0.85**

Findings from Cognitive Interviews

All six participants (four females, two male) were alumni CHWs from the InTOuCH training program and identified as African American. Participants consented to participate and be recorded for the study. For each of the 46–items, CHWs provided feedback in their own words about difficulty of items, clarity, thought process on choosing the answer responses, and comments on areas for improvement. A few issues concerning clarity of item wording, response options, and instructions were identified during the interview, and consequently amended. Problems uncovered during the interview were assessed and used for item revision. Participants also indicated that the approximate time needed to complete the test was 30 minutes. They expressed that they felt comfortable using Qualtrics for test taking, but provided some valuable feedback such as the need for a "next button" at the end of each page, larger font size and addition of a completion bar.

Confusing Question: ""It's too wordy, breaking it into two parts would be helpful"

Confusing Response Option: "Many people believe in taking medication only when they have symptoms, that was confusing for me"

Variable Interpretation of terms: "For me, physical activity was the extra punch, so I just took a guess"

Inadequate instructions: "If I didn't know this was one question, I would be confused"

Discussion

This chapter reports the development and validation of the stroke literacy assessment test (SLAT). An iterative process model for assessment design and use (Phases I–IVA) developed by Chatterji (2003) was applied for assessment context specification, construct domain specification, item pool generation and content–based validity (Chatterji, 2003; Chatterji et al., 2009).

A series of steps were performed in each phase of the *Process Model* to develop the SLAT instrument. First, a thorough review of literature to define the construct domain, learning competencies and contents that items should cover was conducted. A pool of 72–items was generated in this step, more than anticipated for the final version (Nunnally & Bernstein, 1994). The content of the items covered the seven modifiable risk factors (MRF) and prevention measures for stroke (hypertension, smoking cessation, high blood cholesterol, diabetes, physical inactivity, obesity, and unhealthy eating/diet). Next, the pool of items was subject to content validation by expert reviews to ensure alignment with specification and underlying cognitive taxonomies. Each of the items were scored by the experts for content relevance, clarity, conciseness, and a content validity index (CVI) was calculated. Items that failed content validation were either removed or tweaked to create a smaller, valid set of questions. Lastly, the 46–item pool that was assimilated in this process was validated for response processes by a purposive sample of CHWs.

The overall evidence from this evaluation satisfactorily supports validity of the "Stroke Literacy" domain. The scale CVI of 0.90, 0.82, and 0.85 for content relevance, clarity and conciseness respectively demonstrated high content validity for the scale. Cognitive interviews (N=6) revealed that items were of moderate to high difficulty level, and aligned with the intended interpretation of the items, but required minor revisions in wording and formatting. Following these steps, a 46–item test validated for content was assembled for field testing.

However, one important limitation pertaining to item representation to the underlying competencies was noted during this process. Following the content validation by experts, 26 items were removed. This left the smaller 46–item test with too few items under each stroke risk factor indicator and competencies. This iteration of the SLAT was further evaluated with empirical validity and reliability evidences, described in detail in chapter IV.

Conclusion

In conclusion, development of the SLAT to assess competencies of community health workers would be the first of its kind designed to test varying cognitive levels in stroke risk factors and prevention measures. The use of the iterative *process model* which is grounded in measurement and validation theory allows for systematic design of a rigorous assessment tool specifically designed for CHWs. As the SLAT focuses on the seven key risk factors, common to most chronic diseases it could be generalizable to lay health workers and other paraprofessionals in chronic disease prevention.

Additionally, this tool will not only strengthen the existing InTOuCH program, it will potentially fill a critical gap in the field of community health education.

CHAPTER IV

EMPIRICAL VALIDATION OF THE STROKE LITERACY ASSESSMENT TEST

Introduction

Stroke, the fifth leading cause of death and the leading cause of long–term disabilities in the United States, together with heart disease it accounts for approximately $320 billion in healthcare costs every year (Healthy People, 2020). Nevertheless, 90% of all strokes remain preventable and can be attributed to seven key modifiable risk factors (MRF) (Hankey, 2020). The seven key MRFs in stroke prevention include: include high blood pressure (BP), high cholesterol, diabetes mellitus (DM), smoking, obesity, unhealthy diet, and physical inactivity (Diener & Hankey, 2020). The American Heart Association (2020), has recognized the modification of these seven MRFs as the goal to achieve ideal cardiovascular health (Virani et al., 2020).

In the United States, CHWs are recognized as an essential public health workforce in managing chronic disease, particularly in hard–to–reach and underserved populations (Covert et al., 2019; Sabo et al., 2017). Their role in stroke prevention interventions have shown to be highly effective in lowering risk factors (hypertension, diabetes, cholesterol) and increasing healthy behaviors (improved body weight, physical activity (PA), healthy eating, and smoking cessation) among high–risk individuals (Brownstein et al., 2005; Brownstein et al., 2007; Covert et al., 2019; CTSF, 2015; Towfighi et al., 2017). CHWs are known to perform these tasks with basic training specific to the context of the intervention(s), often with no formal professional or educational background (Kok et al., 2015; Kok et al., 2017). However, for CHWs to optimally perform their roles, they need to be prepared with solid initial training, rigorous competency tests, on–going monitoring, and continuing education (Kapheim & Campbell, 2014).

Currently, various components of the CHW workforce development in the United States are deficient, including: 1) national accreditation and credentialing, 2) standardized training curriculum, 3) rigorous competency evaluations, and 4) the use of validated instruments to measure performance (Scott et al., 2018).

Further, a scoping review of literature of stroke–focused competency assessment instruments for CHWs revealed that although they were assessed for knowledge, skills, and self–efficacy the assessment instruments used were mostly derived from the training curriculum or independently developed by researchers specific to the training needs and were not validated. Only a small number of studies (9 of 30) used previously validated instruments—such as the Diabetes Knowledge Test (DKT) (Colleran et al., 2012; Han et al., 2007; Look et al., 2008; Policicchio & Dontje, 2018; Tang et al., 2011; Vaughan et al., 2020); Diabetes Attitude Scale (DAS) (Colleran et al., 2012; Look et al., 2008; Policicchio & Dontje, 2018; Zurawski et al., 2016); Diabetes Knowledge Questionnaire (DKQ) (Tang et al., 2011); Coronary Heart Disease Knowledge Test (Moleta et al., 2017); and System for Observing Fitness Instruction Time for Group Exercise Classes (SOFIT–X) (Haughton et al., 2015).

This study sought to fill this gap by developing the stroke literacy assessment test (SLAT), an original instrument designed to assess CHW knowledge pertaining to the seven key MRFs for stroke. Items that passed the necessary content–validation process were used for the empirical tryout in this phase.

In this chapter, results of the empirical validation and reliability testing of the SLAT is presented. The validity evidence was investigated by item analysis to select the best functioning items and to maximally discriminate between the high and low performing CHWs. Reliability scores for internal consistency of the test and evidence of group differences based on logical assumptions (education level, pervious health–related work experience, and number of years of experience as a CHW) were also investigated.

Methods

This research study was conducted in compliance with the Institutional Review Board of Teachers College, Columbia University. A research protocol and informed consent form were developed for the study participants. The informed consent provided details of the research aims, risks, benefits, data privacy and confidentiality procedures. The research files linking names and identifiers were saved on a password–protected computer, and only the investigator had access to the file. All study data were stored in encrypted files in a secure location to protect confidentiality.

Study Setting and Population

The SLAT was designed specifically to assess stroke literacy knowledge in community health workers in a stroke prevention training program. To field–test this instrument, community health worker alumni from the Columbia University InTOuCH program participated. The InTOuCH program is an eight–week comprehensive stroke prevention training that trains community volunteers from the Harlem neighborhood in New York City to be CHWs. This innovative program centered in Harlem—where the prevalence of stroke is relatively higher than other neighborhoods in the city—was designed to increase stroke awareness and education through members within their community.

The program's curriculum covers a range of health topics, including stroke, heart attack, diabetes, high blood pressure, high cholesterol, smoking cessation, health eating, obesity, physical activity, motivational interviewing, and navigating the NYS health insurance. Through this training program, CHWs become proficient in stroke literacy and in practical skills such as blood pressure measurement techniques, and acquire effective communication skills for stroke and CVD health counseling.

For the empirical validation, CHWs from 11 cohorts of the InTOuCH program trained between 2016–2021 were invited (n=132) to participate. 81 participants responded of which 68 respondents' data was usable. Criteria for inclusion were ages 18 and older, fluent in English, and a CHW graduate of the InTOuCH training program.

Survey Instrument

A 54–item survey was developed to collect empirical data from the CHWs. The survey comprised of two parts: 1) eight questions on demographic information, 2) 46–item SLAT covering the seven key MRFs (i.e., hypertension, smoking, high blood cholesterol, diabetes, physical inactivity, obesity, and diet), and 3) prevention measures.

The demographic information included age, gender, race, highest level of education, current employment status, professional background, past health–related work experience, and number of years of experience as a community health worker.

The SLAT is an individual assessment written structured–response (W–SR) test. The test consists of the following W–SR formats: 27 multiple–choice questions (MCQ) with four–answer options, ten true–false (T/F) questions (one modified T/F), and nine matching questions. Each item in the SLAT is coded for the *Functional Taxonomy's* knowledge dimension and measures factual knowledge and application levels of cognition. The readability level determined by the Flesch–Kincaid Grade level obtained from Microsoft word was 7.3 with a reading ease of 62.9.

Data Collection

Data collection began in March 2021 and continued through May 2021. The survey was generated using Qualtrics® software (Provo, UT). The survey was shared via an email–embedded link to the CHW alumni of the InTOuCH training program described above. The link included an informed consent, description of the research, participant's rights, and steps taken to maintain confidentiality. As an indication of having read and understood their rights to participate, they were instructed to provide an electronic signature. Following these steps, the study participant was directed to the survey with demographic questions, detailed instructions for test–taking and the 46–item stroke literacy assessment test. The test was active for six weeks and participants had to complete the test in one sitting. All study data were stored in password–protected, encrypted files to provide a secure data repository and protect confidentiality.

Analyses

The latest iteration of the SLAT (46–items) was used in this phase of the study. A correct response was awarded one point, while an incorrect response was worth zero. The SLAT total score was calculated by summing across items with a maximum possible score of 46, with higher SLAT scores indicating greater knowledge in stroke literacy. The data on all items for which valid responses were received were retained, and missing responses were marked as incorrect.

Descriptive statistics were used to summarize the participant characteristics, and test scores. To evaluate the validity and reliability of the SLAT, three analyses were performed: 1) item analysis to examine item difficulty statistics (p_i value) and item discrimination index (D value), 2) internal consistency estimates of reliability by calculating Cronbach's α, and 3) a one–way analysis of variance (ANOVA) to ascertain whether participants with higher education, previous health–related work experience, and number of years of experience as a CHW would score higher on the SLAT.

Item Analysis.

The item difficulty index (p_i value) is the proportion of test–takers who get an item right by selecting the keyed response and range from 0.00–1.00. The higher the p_i value, the easier the item, i.e., a p_i value of .95 indicates that 95% of the test–takers responded correctly to the item. The item discrimination index (D value) is the difference in proportions of test–takers who get an item right in two well–defined groups (Chatterji, 2003). The discrimination index in this case indicates how well the item discriminates between CHWs who are knowledgeable versus those who are not or (high and low scorers). The D values range from – 1.0 to +1.0.

A useful approach when reviewing a set of item discrimination indices is to also view each item's p_i value simultaneously. As per guidelines, in a norm–referenced test (NRT), the calculated item statistics and the qualitative characteristics of the item are reviewed in conjunction with the results of the quantitative item analysis (p_i value and D value). Here, the p_i values should ideally range from .50 to .70 and all items should show positive discrimination indices. The goal of a NRT is to have moderate levels of item difficulty (Chatterji, 2003, p. 393). If p_i values are found to be below .40, the item is likely to be operating at a fairly high level of difficulty (in a four–option item, chance level is 25%). Regardless of the p_i value, a D value of 0 indicates that an item has no discriminating ability, making it useless as an NRT item (Chatterji, 2003, p. 393).

Internal Consistency Reliability.

Estimates for the stroke literacy domain and total scores were determined using Cronbach's α. Items with a negative discrimination index, that is, those discriminating in the reverse direction from the hypothesis were dropped to improve the internal consistency reliability of the instrument.

Validity Based on Group Differences.

Additional validity evidence was gathered based on logical expected group differences. Higher education, previous health–related work experience, and greater number of years of experience as a CHW were hypothesized to be associated with higher test scores. In examining the group differences, a p value of 0.05 was considered statistically significant.

SPSS statistical software was used for all analyses (version 27.0; IBM Corporation, Armonk, NY).

Results

Demographics

During the six–week data collection period, 81 CHWs responded to the survey. All the CHWs were graduates of the InTOuCH training program (described above) from 2016 – 2021.

The demographic characteristics and work experience of the study sample are presented in Table. 4.1. The surveys were completed by 68 CHWs in total. Majority of participants (86.8%) were female. 7.4% of CHWs were between the ages of 18 and 41, 25% were between the ages of 41 and 60, and 67.6% were between the ages of 61 and 90.

60 of the 68 participants identified as Black/African American (89.6%), 5 identified as American Indian or Alaska Native (7.5%), one identified as White or Caucasian (1.5%), and one as Asian (1.5%). Majority of the participants had a college education (38.2%) or graduate or professional degrees (50.0%), and more than half of them (36) were retired. 57.4% of them had previous health–related work experience, including nursing, social work, community health advisor, lifestyle educator, wellness coach, home health aide, mental health and substance use counselor, and medical missionary educator.

The number of years of experience as a CHW varied; 23.5% had six months – 1 year of experience, 55.9% (2 – 5 years), and 20.6% (5 – 10 years).

Overall, there were a high number of female CHW participants. They had a high education level and more than half of them had a previous health–related work experience and at least 2–5 years of experience as CHW.

Table 4.1. Demographic Characteristics of CHWs (N=68)

Characteristic	Frequency	Percent (%)
Age		
18 – 40 years	5	7.4 %
41 – 60 years	17	25.0 %
61 – 90 years	46	67.6 %
Gender		
Female	59	86.8 %
Male	9	13.2 %
Race		
Black or African American	60	89.6 %
White or Caucasian	1	1.5 %
Asian	1	1.5 %
American Indian or Alaska Native	5	7.5 %
Education		
Less than High School	5	7.4 %
High School – GED	3	4.4 %
College – Associate's Degree	26	38.2 %
Graduate – Professional Degree	34	50.0 %
Employment		
Volunteer	1	1.5 %
Disabled	5	7.4 %
Homemaker	2	2.9 %
Retired	36	52.9 %
Working Part – time	3	4.4 %
Working Full – time	12	17.6 %
Other	9	13.2 %
Health–related Work Experience		
Yes	39	57.4 %
No	29	42.6 %
CHW Experience		
6 months – 1 year	16	23.5 %
2 – 5 years	38	55.9 %
5 – 10 years	14	20.6 %

Psychometric Analysis

Validation of Cognitive Demands of Items.

An iterative diagnostic analysis of the item–to–total statistics using Classical Test Theory (CTT) techniques was conducted. Results from two iterations are presented in Tables 4.2 & 4.5.

1st Iteration.

In the first round of analysis, 43 of 46 items were used to compute item statistics (Table 4.2). Three items (#4, #7, and #15) with no variance were excluded by SPSS from the item analysis as they were 'too easy' and were answered correctly by all respondents. For the 43 items that were analyzed, the modal range for item difficulty was 0.07 to 0.98, indicating that the test had heterogeneous items ranging from very easy to very difficult. Item discrimination data ranged from –0.30 to +.48, with 12 items (#2, #3, #6, #16, #19, #20, #28, #32, #34, #35, #36, #39) discriminating negatively, or items in which the low group outperformed the high group.

Table 4.2. 1st Iteration: Item to Total Statistics

	Item #	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Item Mean (p_i)	Corrected Item–Total Correlation (D)	Cronbach's Alpha if Item Deleted
1	Item 1	29.52	10.922	0.98	.024	.442
2	Item 2	29.52	11.188	0.98	-.247	.455
3	Item 3	29.57	10.918	0.93	-.008	.445
4	Item 5	30.07	10.640	0.43	.023	.448
5	Item 6	29.70	11.016	0.80	-.079	.459
6	Item 8	29.52	10.611	0.98	.348	.424
7	Item 9	29.65	10.099	0.85	.319	.405
8	Item 10	29.57	10.340	0.93	.351	.413

9	Item 11	30.04	10.131	0.46	.181	.419
10	Item 12	29.85	10.621	0.65	.036	.445
11	Item 13	29.67	10.447	0.83	.151	.427
12	Item 14	29.57	10.607	0.93	.183	.428
13	Item 16	29.85	10.843	0.65	-.034	.457
14	Item 17	29.63	10.505	0.87	.157	.428
15	Item 18	29.59	10.603	0.91	.152	.430
16	Item 19	29.52	11.100	0.98	-.157	.451
17	Item 20	29.91	10.792	0.59	-.022	.456
18	Item 21	30.09	10.526	0.41	.060	.442
19	Item 22	29.63	10.549	0.87	.136	.430
20	Item 23	30.17	10.458	0.33	.093	.436
21	Item 24	29.61	10.732	0.89	.066	.439
22	Item 25	29.78	9.818	0.72	.330	.395
23	Item 26	29.67	10.669	0.83	.060	.440
24	Item 27	29.59	10.337	0.91	.300	.414
25	Item 28	30.43	11.096	0.07	-.115	.454
26	Item 29	29.63	10.194	0.87	.302	.409
27	Item 30	29.54	10.565	0.96	.268	.424
28	Item 31	30.04	10.665	0.46	.015	.450
29	Item 32	30.33	11.336	0.17	-.200	.474
30	Item 33	29.54	10.920	0.96	.003	.443
31	Item 34	29.52	10.966	0.98	-.022	.444
32	Item 35	30.02	11.755	0.48	-.301	.503
33	Item 36	30.11	11.388	0.39	-.200	.485
34	Item 37	29.96	9.731	0.54	.312	.395
35	Item 38	30.04	10.354	0.46	.111	.432

	Item #	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Item Mean (p)	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
36	Item 39	30.35	11.343	0.15	-.208	.473
37	Item 40	29.65	10.765	0.85	.029	.444
38	Item 41	29.72	10.563	0.78	.085	.436
39	Item 42	29.72	9.541	0.78	.486	.373
40	Item 43	30.00	9.733	0.50	.310	.395
41	Item 44	29.61	10.466	0.89	.197	.424
42	Item 45	29.91	9.681	0.59	.335	.391
43	Item 46	29.59	10.337	0.91	.300	.414

Following recommendations outlined by Wyer and Chatterji (2013) item difficulty values were categorized into ranges from very difficult (0–.39) to very easy (.90–1.00) (Wyer & Chatterji, 2013). A table of specifications (Table 4.3) was created to categorize the items linked to taxonomic levels under each difficulty range (Chatterji, Graham, & Wyer, 2009). An item–by–item iterative diagnostic analysis was performed to ensure that the items in the “stroke literacy” domain matched the cognitive level of specifications.

Table 4.3. 1st Iteration: Cognitive Level Specifications versus Item Difficulty

Content	Cognitive Level	Item p value range: 0.90 to 1.0 Very Easy (*D* value)	Item p value range: 0.70 to 0.89 Easy (*D* value)	Item p value range: 0.40 to 0.69 Difficult (*D* value)	Item p value range: 0.0 to 0.39 Very Difficult (*D* value)	Total # of Items (Weights)
Hypertension	Factual Knowledge	1 MCQ (-.247)	1 MCQ (-.079)	1 MCQ (0.23)	0	3
	Application	1 MCQ (.24) 1 T/F (-.008)	0	0	0	2
Smoking Cessation	Factual Knowledge	1 T/F (.348) 1 MCQ (.351)	1 T/F (.319)	0	0	3
	Application	0	0	0	0	0
High Cholesterol	Factual Knowledge	1 T/F (.183)	1 MCQ (.151) 1 Matching (.085)	1 MCQ (.036) 1 T/F (-0.34)	0	5
	Application	0	0	1 MCQ (.181)	0	1
Diabetes Mellitus	Factual Knowledge	1 MCQ (.152) 1 MCQ (-.157)	1 MCQ (.157) 1 MCQ (.136)	1 MCQ (.060)	1 T/F (-.022)	6
	Application	0	0	0	0	
Physical Inactivity	Factual Knowledge	1 MCQ (.300)	1 MCQ (.066) 1 MCQ (.330) 1 MCQ (.060)	0	1 MCQ (.093)	5
	Application	0	0	0	0	
Obesity	Factual Knowledge	1 MCQ (.015)	0	1 Matching (.310) 1 Matching (.335)	0	3
	Application	1 MCQ (.268)	1 MCQ (.302)	0	1 T/F (-.115) 1 MCQ (-.200)	4

Content	**Cognitive Level**	**Item p value range: 0.90 to 1.0 Very Easy (*D* value)**	**Item p value range: 0.70 to 0.89 Easy (*D* value)**	**Item p value range: 0.40 to 0.69 Difficult (*D* value)**	**Item p value range: 0.0 to 0.39 Very Difficult (*D* value)**	**Total # of Items (Weights)**
Diet	Factual Knowledge	1 MCQ (.003) 1 Matching (.300)	1 T/F (.029) 1 Matching (.486) 1 Matching (.197)	1 MCQ (-.301) 1 MCQ (.312)	1 MCQ (-.200)	8
	Application	1 MCQ (-.022)	0	1 MCQ (.111)	1 MCQ (-.208)	3
Total Number of Items on Test						43

Note: MCQ: Multiple–choice question; T/F: True or False; Item #4, #7, #15 showed no variance and were excluded from item analysis.

The first iteration of the diagnostic item analysis revealed that 33% of items were very easy and 14% were very difficult. 22 of 46 items had a p_i value of 80% or higher with a positive D value (i.e., 47.82%).

Overall, (36 of 46) or 78% of the items tested in the factual knowledge level of cognition, with 75 percent ranging from *easy* to *very easy*. There were only ten application questions on the SLAT, with an equal number of easy and difficult items. This distribution pattern suggests that the test was generally easy and that the content in the targeted learning outcomes was not adequately represented.

Malfunctioning Items.

To identify malfunctioning items, the item difficulty value and discrimination index for the pool of 43 items were examined together. The probability of selecting the correct answer for multiple choice items with four answer options is 25%. According to these criteria, an item difficulty value of .25 or lower indicates that it performed below the chance level. If such items had a D value of 0 or a negative D value, they were labeled as "problematic." Two items were identified as performing below chance and negatively discriminating (#28, #32).

Ten more moderately difficult, but negative discrimination items were identified as problematic (#2, #3, #6, #16, #19, #20, #34, #35, #36, #39). This iteration dropped a total of 12–items, resulting in a total of 31–items. The item characteristics and their interpretation are summarized in Table 4.4. The reverse discrimination of the items indicates that the wording maybe confusing, or that it failed to fit the stroke literacy domain.

Table 4.4. Interpretation of Item Analysis for SLAT

Item Characteristics	Interpretation	Item #	Action
p values .49 to .70 *D* values of + 1.0 to +.40 Distracters and correct options show predictable response distributions in high and low groups	Desirable NRT item	#37, #43, #45, #12, #40, #41	Items retained.
p values higher than .70 or approaching .90 *D* values positive	Easy or too–easy item	#1, # 4, #7, #8, #9, #10, #13, #14, #15, #17, 24, #33, #18, #22, #25, #27, #29, #30, #42, #44, #46	Items retained for revision to raise difficulty in next iteration.
p values .40 or lower *D* values of +.40 or higher Distracters and correct options show some unpredictable patterns	Difficult or too–difficult item	#5, #11, #21, #23, #31, #38	Items retained to improve difficulty level.
p values equal or close to chance level *D* values of 0, or negative	Poor item	#2, #3, #6, #16, #19, #20, #28, #32, #34, #35, #36, #39	Items dropped.
Item #4, #7, #15 showed no variance and did not compute *p* value or *D* value and were included in the 'very easy' items for revision.			

2nd Iteration.

The 31 items from the first iteration were used to compute another round of item statistics (Table 4.5) A second round of diagnostic item analysis was performed on the 31 items, with only one item (#31) having a negative discrimination index which was retained because the content was clinically relevant.

Table 4.5. 2nd Iteration: Item to Total Statistics

	Item #	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Item Mean (p)	Corrected Item–Total Correlation	Cronbach's Alpha if Item Deleted
1	Item 1	22.23	13.314	0.98	0.010	0.674
2	Item 5	22.79	12.736	0.43	0.101	0.676
3	Item 8	22.23	13.009	0.98	0.299	0.666
4	Item 9	22.36	12.540	0.85	0.265	0.661
5	Item 10	22.28	12.639	0.94	0.367	0.658
6	Item 11	22.74	12.281	0.47	0.229	0.663
7	Item 12	22.57	12.685	0.64	0.123	0.674
8	Item 13	22.38	12.633	0.83	0.210	0.665
9	Item 14	22.28	12.944	0.94	0.191	0.667
10	Item 17	22.34	12.795	0.87	0.181	0.667
11	Item 18	22.30	12.866	0.91	0.198	0.666
12	Item 21	22.81	12.897	0.40	0.057	0.681
13	Item 22	22.36	12.845	0.85	0.144	0.670
14	Item 23	22.89	12.445	0.32	0.204	0.666
15	Item 24	22.32	13.048	0.89	0.089	0.673
16	Item 25	22.51	11.864	0.70	0.398	0.647
17	Item 26	22.40	12.768	0.81	0.147	0.670
18	Item 27	22.30	12.692	0.91	0.285	0.661
19	Item 29	22.34	12.708	0.87	0.218	0.665
20	Item 30	22.26	12.846	0.96	0.312	0.663
21	Item 31	22.77	13.140	0.45	-0.013	0.688

	Item #	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Item Mean (p)	Corrected Item–Total Correlation	Cronbach's Alpha if Item Deleted
22	Item 33	22.26	13.194	0.96	0.074	0.672
23	Item 37	22.66	12.316	0.55	0.220	0.664
24	Item 38	22.77	12.401	0.45	0.196	0.667
25	Item 40	22.38	12.633	0.83	0.210	0.665
26	Item 41	22.43	12.815	0.79	0.121	0.672
27	Item 42	22.43	11.772	0.79	0.494	0.640
28	Item 43	22.72	11.813	0.49	0.368	0.649
29	Item 44	22.32	12.744	0.89	0.227	0.664
30	Item 45	22.64	11.801	0.57	0.377	0.648
31	Item 46	22.32	12.483	0.89	0.347	0.656

Examination of item distribution under cognitive level specifications of the 31 items found that distribution across the stroke literacy domain's learning competencies was not proportionate (Table 4.6). In terms of content relevance, the independent items were distributed across the MRFs competencies as follows: hypertension three of 31 (6.4%), smoking cessation four of 31 (9.6%), high cholesterol five of 31 (16.12%), diabetes four of 31 (12.9%), physical inactivity five of 31 (16.12%), obesity five of 31 (16.12%), and diet seven of 31 (22.5%).

Table 4.6. 2nd Iteration: Cognitive Level Specification versus Item Difficulty

Content	Cognitive Level	Item p value range: 0.90 to 1.0 Very Easy (*D* value)	Item p value range: 0.70 to 0.89 Easy (*D* value)	Item p value range: 0.40 to 0.69 Difficult (*D* value)	Item p value range: 0.0 to 0.39 Very Difficult (*D* value)	Total # of Items (Weights)
Hypertension	Factual Knowledge	0	0	1 MCQ (0.23)	0	1
	Application	1 MCQ (.24)	0	0	0	1
Smoking Cessation	Factual Knowledge	1 T/F (.348) 1 MCQ (.351)	1 T/F (.319)	0	0	3
	Application	0	0	0	0	0
High Cholesterol	Factual Knowledge	1 T/F (.183)	1 MCQ (.151) 1 Matching (.085)	1 MCQ (.036)	0	4
	Application	0	0	1 MCQ (.181)	0	1
Diabetes Mellitus	Factual Knowledge	1 MCQ (.152)	1 MCQ (.157) 1 MCQ (.136)	1 MCQ (.060)	0	4
	Application	0	0	0	0	0
Physical Inactivity	Factual Knowledge	1 MCQ (.300)	1 MCQ (.066) 1 MCQ (.330) 1 MCQ (.060)	0	1 MCQ (.093)	5
	Application	0	0	0	0	0
Obesity	Factual Knowledge	1 MCQ (.015)	0	1 Matching (.310) 1 Matching (.335)	0	3
	Application	1 MCQ (.268)	1 MCQ (.302)	0	0	2

Content	**Cognitive Level**	**Item p value range: 0.90 to 1.0 Very Easy (*D* value)**	**Item p value range: 0.70 to 0.89 Easy (*D* value)**	**Item p value range: 0.40 to 0.69 Difficult (*D* value)**	**Item p value range: 0.0 to 0.39 Very Difficult (*D* value)**	**Total # of Items (Weights)**
Diet	Factual Knowledge	1 MCQ (.003) 1 Matching (.300)	1 T/F (.029) 1 Matching (.486) 1 Matching (.197)	1 MCQ (.312)	0	6
	Application	0	0	1 MCQ (.111)	0	1
Total Number of Items on Test						31
Note: MCQ: Multiple–choice question; T/F: True or False						

Following the item analysis of the 46–item SLAT, measuring the "stroke literacy" domain, it was found that 12 items were not functioning well i.e. items were performing in the reverse direction, where high performers answered these items incorrectly. This was possibly due to errors in item content (domain sampling errors with a heterogeneous mix of items) or item construction (two possible correct answers, confusing language, etc.).

The internal consistency reliability.

The internal consistency reliability is a test accuracy metric that "provides an index of errors inherent in the domain–sampling approach" (Chatterji, 2003, p. 435). To be acceptable, internal consistency estimates should be at least .70 (Crocker & Algina, 1986).

An estimate of internal consistency for the SLAT improved after dropping malfunctioning items (α= .46) to (α= .69). According to standard criteria, the internal consistency reliability for SLAT was found to be at least modest (Cronbach's α= .7) (Nunnally & Bernstein, 1994) (Table 4.7 & 4.8).

Table 4.7. 1st Iteration: Internal Consistency Reliability

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.442	.461	43

Table 4.8. 2nd Iteration Internal Consistency Reliability

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.673	.696	31

Validity Evidence Based on Expected Group Differences.

Testing for hypothesized group differences (education, health–related experience, and years of experience as a CHW) was calculated on the validated total score (34 items) (i.e., 31 items + #4 #7 #15). Only the education group showed a statistically significant difference (p=0.30) (Tables 4.9, 4.10 and 4.11).

However, the Bonferroni post hoc test between the means of the four education groups (Less than high school; High school–GED; College–Associate degree; and Graduate–Professional degree) showed no statistically significant differences.

Table 4.9. ANOVA for Education

Group	N	Mean	SD	Min.	Max.	Mean Difference	F	Sig. (*p*)
More Educated	39	24.26	4.789	8	31	1.19	1.095	.299
Less Educated	29	23.07	4.399	13	30			
Total	68							

Table 4.10. ANOVA for Health Experience

Group	N	Mean	SD	Min.	Max.	Mean Difference	F	Sig. (*p*)
Has Previous Health–Related Experience	39	23.90	5.235	8	31	0.35	.091	.763
Has No Previous Health–Related Experience	29	23.55	3.747	16	31			
Total	68							

Table 4.11. ANOVA for CHW Experience

Group	N	Mean	SD	Min.	Max.	Mean Difference	F	Sig. (p)
Less than 5 years	54	23.61	4.512	8	31	0.68	.233	.631
More than 5 years	14	24.29	5.210	13	30			
Total	68							

Based on the self–report survey, more educated CHWs had added prior training in concepts of stroke and its risk factors versus those who did not. It was hypothesized that, if valid, the test scores would be sensitive to these educational differences, favoring the more educated workers. This hypothesis was confirmed with statistical significance at the $p < .05$ level (Table 4.9). Similarly, CHWs with prior healthcare–related work experience and work experience as a CHW for more than five years were hypothesized to perform better on the test versus those who did not. However, these hypotheses showed no statistically significant group differences (Table 4.10 & Table 4.11).

All of these evidences, taken together, support the desired score interpretations in specific assessment contexts. Content validity provided evidence on the alignment of the test items to the overarching ‘stroke literacy' domain for the SLAT. The diagnostic analysis of the items shed light on the causes of item malfunctioning and allowed for the correction of item flaws in order to create a more tightly packed set of items. Finally, an examination of descriptive and inferential statistics on different subgroups provided evidence for the hypothesized group differences.

Discussion

This study reports the empirical evaluation methods and results of the stroke literacy assessment test (SLAT) for community health workers. The SLAT was designed to tap into the knowledge assessment of the seven MRFs and prevention measures for stroke (hypertension, smoking, high cholesterol, diabetes, physical inactivity, obesity, and unhealthy eating/diet). The current iteration of the SLAT demonstrates sufficient validity and reliability for use with community health workers specializing in stroke prevention efforts. The latest iteration of SLAT is a 34–item, written structured response test that taps into the *factual knowledge* and *application* levels of cognition (Appendix B).

To gather the empirical validity evidence, the SLAT was administered to community health workers previously trained in the InTOuCH stroke prevention training program. Using classical test theory (CTT) approaches, items that passed the necessary content–validation process were used for the empirical tryout. Quantitative item analysis was performed to evaluate the quality of the individual items with respect to the assessment purposes. An iterative diagnostic item analysis process was applied to identify difficulty patterns and malfunctioning items, followed by item deletions, and revisions.

Item difficulty (p_i) and item discrimination (D) indices in conjunction with the item qualitative characteristics were analyzed for each item in the SLAT. The internal consistency reliability estimate was computed by Cronbach's alpha. Items were categorized as *very easy, easy, difficult, and very difficult* and problematic items were considered for deletions or further revisions. Items with a negative discrimination index, that is, those discriminating in the reverse direction from the hypothesis were dropped to improve the internal consistency reliability of the instrument. Following the first iteration, this process was repeated to further refine the instrument.

This study had several limitations. First, the items in the test did not represent higher cognition levels of knowledge such as complex procedural skills, or higher–order thinking skills on the *functional taxonomy* continuum and was an overall easy test. This narrows the focus of assessing deeper learning competencies of the community health workers. Most of the items on the current iteration of the test were on *factual knowledge* and some at the *application* level. Future iterations of the SLAT will be revised to tap into higher levels of cognition while ensuring appropriate representation of items across all learning competencies of the stroke literacy domain. Second, the reliability of the test was relatively low (< 0.69) with several items discriminating in the reverse direction. This is likely due to the non–homogeneity of the items with uneven distribution across learning competencies, too few items tapping into content, and confusing items. The next iteration will incorporate these changes to add more items and revise existing ones, with particular attention to items with negative D values and p values < .2. The refined instrument will be field–tested in a larger sample, and diagnostic item analysis will be repeated to achieve maximum validity and reliability. Third, there was no evidence of group differences by education level, previous health–related experience, and number of years of experience as a CHW as posited by logical assumption. This is possibly due to the homogenous sample that was purposively selected from the InTOuCH training program who had all received the training and had at least one year of experience working as a CHW. Finally, we could not control for the test–taking conditions of the participants. The use of the online format via Qualtrics, may have posed technical challenges to some participants unfamiliar with this platform. However, to address these challenges, a trial run with a sample of CHWs was conducted to gauge their usability of this platform.

Despite these limitations, the SLAT has several strengths. First, the SLAT we developed and tested contributes to the critical gap in rigorous competency assessments for community health workers employed in chronic disease prevention implementation. Second, the SLAT would be the first valid and reliable tool that will be developed specifically for CHWs who receive limited formal training but learn complex stroke prevention concepts. Third, the SLAT will be used for forth coming CHW trainees in the InTOuCH program, to strengthen the program, and help summative decision making for the program implementers. This test will provide a structure to stroke prevention CHW programs that are moving toward integration into the healthcare system.

Conclusion

This study presents the design of the SLAT using a unified approach to validation. The iterative, instrument design and evaluation efforts were based on four types of validity evidence plus internal consistency reliability evidence of the final, most refined version of the tool: 1) content validation with expert reviews of items and overall domain, 2) validation on examinee response processes with a small sample cognitive interviews, 3) item validation and diagnostic analysis, and 4) validity evidence based on expected directional group differences on the final, total scores. In addition, the internal consistency reliability of the total test scores, with best functioning 31 items were evaluated. The SLAT thus addresses a critical gap in the competency assessments of CHWs in stroke literacy that has been largely overlooked, and provides scores with an acceptable validity and reliability. Although further evaluations of psychometric properties are needed to fully characterize this test, the preliminary results of the SLAT suggest that it is sensitive to measuring varying levels of knowledge pertaining to the modifiable risk factors for stroke. Potential applications of this test include its use in assessing individual CHW competencies in stroke and CVD training programs, for summative decision making for trainers, and as a tool to measure CHW performance toward development of a competent workforce in the health care system.

CHAPTER V

DISCUSSION AND RECOMMENDATIONS

The purpose of this research was to create a valid and reliable test to assess knowledge of community health workers (CHW) pertaining to the seven key modifiable risk factors (MRF) for stroke. The specific aims of this work were to: 1) identify gaps in the literature related to assessment measures in stroke literacy for community health workers, 2) assess and evaluate the need for a stroke literacy assessment test for community health workers, 3) demonstrate evidence of the validity and reliability for the stroke literacy assessment test, and 4) assess stroke literacy using the test in a sample of CHWs in the InTOuCH stroke prevention training program. This dissertation comprises three distinct but related reports, which, when combined, form manuscripts that contribute significant new findings to the CHW literature. In the first part, the dissertation presents a comprehensive scoping review of literature of stroke–focused competency assessment methods for CHWs. Specifically, this review synthesizes the types of assessment tools used to measure CHW competencies in the seven MRFs for stroke, explores if such assessment tools were validated, and describes the psychometric properties of the instrumentation, and results on performance outcomes. In the second and third parts, the dissertation presents the methodology and results of the development and evaluation of a novel stroke literacy assessment test (SLAT) for community health workers. The purpose of this chapter is to summarize the findings from each of these three chapters, synthesize and discuss the critical need for a stroke–focused assessment test for community health workers, and to make recommendations for future research with further iterations of the SLAT and its importance to the integration of CHWs into the health care system.

Discussion

Stroke remains a major cause of death and disability in the United States, and its impact is likely to increase in the future due to the impending shortage of healthcare workers and ongoing demographics changes, including ageing of the population (Feigin et al., 2016; IOM, 2009; Mercer, 2018). Furthermore, there are significant disparities in stroke incidence and mortality, especially among Blacks and Hispanics. These disparities are attributed to the different effects of risk factors on minority groups, such as high blood pressure, lack of access to health care, ineffective risk factor control, and genetic predisposition to stroke risk factors (Gutierrez & Williams, 2014). They also lack knowledge and awareness of stroke risk factors, and timely prevention methods putting them at twice the risk for having first–time strokes (Covington et al., 2010; Levine et al., 2020). Many also experience inequitable stroke prevention due to cultural and communication barriers, and other forms of structural inequity (Bufalino et al., 2020).

For all of the above reasons, the World Health Organization (WHO), and the American Heart Association (AHA) recommend population– wide stroke prevention strategies that are culturally competent, specifically through community health workers (Feigin et al., 2020; WHO, 2018). Fortunately, there is already sufficient evidence of CHWs' effectiveness in stroke prevention efforts, owing to their community connectedness, diversity, ability to assist with health insurance, and as essential links between communities and the health care system.

However, for a workforce this unique and that performs so many wide–ranging roles, CHWs are not yet recognized as an essential part of the health system. Despite inclusion as a health profession by the US Department of Labor Standard Occupational Classification (21–094) and the Patient Protection and Affordable Care Act (Sabo et al., 2017), critical gaps in CHW workforce development still exist. There are no national guidelines for credentialing, accreditation, training curriculum, or assessment methods. Without, specific guidelines for rigorous training or assessment methodology, researchers and program implementers continue to replicate efforts or use out–of–date and invalidated approaches to prepare CHWs for fieldwork.

The first chapter discussed the epidemiology of stroke, the importance of risk factor modification, prevention strategies, and the effectiveness of CHWs in stroke prevention in high–risk populations. To that end, this chapter includes a description of a novel community health worker stroke prevention program—*Columbia's Institute for Training and Outreach (InTOuCH)*—in New York City's high–risk neighborhood of Harlem. It also provides a rationale for the SLAT's development, which includes the need for rigorous competency assessment methods for credentialing InTOuCH CHWs, program summative decision making, and ultimately filling a critical gap in the CHW field.

Chapter two presented findings of a scoping review of literature on stroke–focused assessment methods for CHWs in the United States. The aims of this review were to: 1) provide a summary of competency assessment methods used in stroke– focused CHW training programs in the country, and 2) identify existing CHW validated assessment tools for knowledge and skills in stroke and cardiovascular risk factors. Specifically, this review aimed to synthesize the types of assessment tools used to measure CHW competencies in the seven MRFs for stroke, to explore if such assessment tools were validated, to describe the psychometric properties of the instrumentation, and results on performance outcomes. Six online databases were searched, yielding 1,774 initial articles, 30 of which were eligible for inclusion in the review. Nine of these studies used previously validated instruments, while the remaining 21 used tools from the training curriculum or instruments developed independently. Only five of these validated tools reported psychometric properties, and none were designed for the CHW population.

This review found that current assessment tools are insufficient for accurately and reliably assessing CHW competencies in stroke prevention. This reinforces the urgent need for the development of a comprehensive and valid stroke prevention assessment instrument to evaluate CHW performance in order to maximize their credibility and as a first step toward their integration into healthcare systems.

Chapter three reported the development and validation of the stroke literacy assessment test (SLAT) for CHWs using the iterative *process model* for assessment design and use (Phases I–IVA) developed by Chatterji (2003). This chapter details the methodology used for context specification, SLAT assessment specification and classification of indicators and learning outcomes for the 'stroke literacy' construct using the *functional taxonomy* (Chatterji, 2003). This chapter also describes the item pool generation for SLAT and results of content validation by experts and validation of responses processes. Following these steps, a 46–item content–validated test was created for field testing.

Finally, in chapter four, the empirical evaluation methods and results of the stroke literacy assessment test (SLAT) for CHWs are reported. The SLAT was administered to CHWs who had previously completed the InTOuCH stroke prevention training program in order to collect empirical validity evidence. Items that passed the necessary content–validation process were used for the empirical tryout using classical test theory (CTT) approaches. To evaluate the quality of the individual items in relation to the assessment purposes, quantitative item analysis was performed. To identify difficulty patterns and malfunctioning items, an iterative diagnostic item analysis process was used, followed by item deletions and revisions. The most recent SLAT iteration is a 34–item written structured response test with adequate validity and reliability that assesses *factual knowledge* and *application* levels of cognition.

There are some limitations to this study. First, the data were drawn from a small sample consisting of CHWs who were previously trained in the Columbia InTOuCH program. Therefore, all the CHWs were already sensitive to instruction and had a baseline knowledge of the test's content, which may have influenced the results. Second, there are no stroke–focused, validated assessment tests in the literature that can be used to assess knowledge in community health workers. As a result, future studies will need to explore how validity and reliability can be improved.

Recommendations

The most significant gap, as seen in the extensive scoping review of literature, is the lack of sound assessment measures for CHW competencies in stroke literacy. This dissertation reports the first attempt to construct a valid and reliable assessment test to fill this gap with the SLAT.

The SLAT has a number of strengthens: 1) it is comprehensive and includes all seven key MRFs; 2) it has been designed and validated specifically for the CHW population; 3) it is applicable to almost all chronic diseases with common risk factors; 4) its development followed a systematic, iterative, and cyclical process model; and 5) it attempts to tap into all cognitive taxonomies. However, future research should focus on the following areas to further refine this test: 1) additional SLAT iterations to achieve maximum validity and reliability, through empirical tryouts with a larger population; 2) creation of the SLAT Skills instrument for assessing complex procedural skills (psychomotor domain); 3) creation of the SLAT Self–Efficacy Scale to measure affective components (affective domain). This approach will help the Columbia InTOuCH program in producing a strong and competent cadre of CHWs, thereby significantly contributing to strengthening of the CHW workforce.

Robust education competency assessments serve as a "quality assurance mechanism," ensuring that all health professionals have the same knowledge and skill set—psychometric evaluations of educational measures are an important first step in conducting this type of evaluative inquiry. There are currently no instruments that are developmentally informative or psychometrically validated for assessing CHW disease–specific knowledge, skills, and behavior. Measuring core competencies alone is no longer sufficient for CHWs who learn and apply complex medical concepts.

With the World Health Organization (WHO) and Human Resources for Health workforce (HRH) 2030 already making significant strides toward the integration of CHWs into the health system, an urgent need for the development of comprehensive and valid assessment instruments such as the SLAT is an essential first step to support CHW performance and determine their readiness to deployment for fieldwork.

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Appendix A: Specification of Construct Domain for SLAT

Construct: Stroke Literacy (Cognitive Domain)

General Indicator

1.0 Stroke Risk Factors – Competent CHWs will be able to demonstrate knowledge of the seven modifiable risk factors and prevention measures of stroke (hypertension, smoking, high blood cholesterol, diabetes, physical inactivity, obesity, and diet) (Boehme et al., 2017; Virani eta al, 2020).

Specific Indicators

1.1 CHWs demonstrate knowledge of hypertension and how to prevent it

- 1.1.3 Identify causes of hypertension *(Factual Knowledge)*
- 1.1.4 Demonstrate knowledge of blood pressure measurement *(Application)*
- 1.1.5 Interpret the meaning of systolic and diastolic pressure *(Application)*
- 1.1.6 Demonstrate knowledge of prevention and control of hypertension (*Factual Knowledge/Application*)

1.2 CHWs demonstrate knowledge of risk of smoking and how to prevent it

- 1.2.1 Recognize the risks and benefits of smoking *(Factual Knowledge)*
- 1.2.2 Associate the importance of quitting smoking to stroke *(Factual Knowledge)*
- 1.2.3 Demonstrate knowledge of methods of smoking cessation *(Factual Knowledge)*

1.3 CHWs demonstrate knowledge of high blood cholesterol and how to prevent it

- 1.3.1 Demonstrate knowledge of the types of cholesterol *(Factual Knowledge)*
- 1.3.2 Demonstrate knowledge of cholesterol testing *(Factual Knowledge)*
- 1.3.3 Interpret the cholesterol numbers *(Application)*
- 1.3.4 Demonstrate knowledge of prevention and control of high cholesterol *(Factual Knowledge)*

1.4 CHWs demonstrate knowledge of diabetes and how to prevent it

- 1.4.1 Distinguish between Type 1 and Type 2 diabetes *(Factual Knowledge)*
- 1.4.2 Demonstrate knowledge of A1C testing *(Factual Knowledge)*
- 1.4.3 Demonstrate knowledge of diabetes prevention management *(Factual Knowledge)*

1.5 CHWs demonstrate knowledge of physical activity and its benefits

- 1.5.1 Recall the AHA's recommended guidelines for physical activity *(Factual Knowledge)*
- 1.5.2 Demonstrate knowledge of physical activity and intensity levels *(Factual Knowledge)*

1.5.3 Interpret relationship of physical activity and HDL *(Factual Knowledge/ Application)*

1.6 CHWs demonstrate knowledge of obesity and importance of weight control

1.6.1 Recognize the association of obesity and stroke *(Factual Knowledge)*

1.6.2 Calculate body mass index *(Application)*

1.6.3 Classify the BMI categories *(Application)*

1.7 CHWs demonstrate knowledge of diet and benefits of healthy eating

1.7.1 Demonstrate knowledge of unhealthy nutrition *(Factual Knowledge)*

1.7.2 Demonstrate understanding of the DASH diet and MyPlate recommendations *(Factual Knowledge)*

1.7.3 Identify the nutrition facts on a food label *(Factual Knowledge)*

1.7.4 Interpret the ingredients on a food label *(Application)*

Appendix B. Stroke Literacy Assessment Test (SLAT)

The following test contains objective questions on stroke risk factors and prevention. Read each question and answer choice carefully and choose the **ONE best answer.** Try to answer all questions. In general, if you have some knowledge about a question, it is better to try to answer it.

Q1 Directions: Look at the blood pressure dial below and answer question 1.

Blood Pressure is measured with two numbers, an upper number and a lower number. It is written as upper/lower. Look at the reading in this figure interpret the blood pressure:

- ○ 142/80
- ○ 80/140
- ○ 78/139
- ○ 140/80

Q2 The upper number is known as systolic pressure and lower number is known as diastolic pressure:

- ○ True
- ○ False

Q3 A person is considered to have hypertension with systolic blood pressure of 140 or higher or diastolic blood pressure of 90 or higher on two separate occasions.

- ○ True
- ○ False

Q4 People with hypertension can skip their medication if they exercise regularly:

- ○ True
- ○ False

Q5 What is the goal blood pressure for a 70-year old man who is taking medicine for hypertension?

- ○ Less than 120/80 mmHg
- ○ Less than 130/80 mmHg
- ○ Less than 160/90 mmHg
- ○ Less than 140/90 mmHg

Q6 Uncontrolled hypertension can lead to which of the following?

- ○ Lung cancer
- ○ High cholesterol
- ○ Kidney failure
- ○ Diabetes

Q7 Mr. Z is a chronic smoker for the last 30 years. After suffering from a stroke, he decides to quit. Which of the following strategies would you recommend to Mr. Z?

- ○ Challenge him to go to places where everyone is smoking
- ○ Smoke low-tar cigarettes
- ○ Smoke low-nicotine cigarettes
- ○ Nicotine replacement

Q8 Quitting smoking reduces the risk of having a stroke by 50%?

- ○ True
- ○ False

Q9 Secondhand smoke exposure is a risk factor for stroke:

- ○ True
- ○ False

Q10 The most addictive substance in cigarettes is?

- ○ Tar
- ○ Tobacco
- ○ Nicotine
- ○ Carbon monoxide

Look at the chart below with the blood cholesterol test results for Mr. Z and answer the questions 11 and 12.

Cholesterol Type	Test Results	Normal Range
Total Cholesterol	250 mg/dL	Less than 200mg/dL
Triglycerides	150 mg/dL	Less than 150mg/dL
LDL	125 mg/dL	Less than 100mg/dL
HDL	30 mg/dL	40mg/dL or higher

Q11 Which of the above readings are the most concerning for risk of stroke?

○ LDL

○ HDL

○ Triglycerides

○ Total cholesterol

Q12 What is a lifestyle modification that can be recommended for Mr. Z to improve his cholesterol levels?

○ Start blood pressure medication

○ Physical activity to increase HDL

○ Increase protein intake

○ Decrease fish oil supplement

Q13 Which is known as good cholesterol?

- HDL
- LDL
- Type 2
- Type II

Q14 The test for cholesterol is known as lipid profile:

- True
- False

Q15 Which one of these foods is more likely to raise people's blood cholesterol?

- Egg whites
- Olive oil
- Animal fat
- Fish oil

Q16 Excess carbohydrates in the diet gets converted to (triglyceride) cholesterol:

- True
- False

Q17 Which of the following is true for **type 1 diabetes?**

- The body does not produce insulin
- It is developed after the age of 30-40
- It can be managed with oral medication
- Obesity is a risk factor

Q18 The A1C is a blood test that measures your average blood glucose level over?

- ○ 6 months
- ○ 30 days
- ○ 3 months
- ○ 10 days

Q19 What effect does exercise have on blood glucose?

- ○ Lowers it
- ○ Raises it
- ○ Has no effect
- ○ None of the above

Q20 In **type 2 diabetes** the pancreas of a person makes little or no insulin

- ○ True
- ○ False

Q21 Mr. Z has a family history of stroke and has been diagnosed with type 2 diabetes. What would be the advice given by his doctor to prevent a stroke?

- ○ Check fasting glucose regularly and keep a log
- ○ Check A1C regularly and keep a log
- ○ Check random glucose regularly and keep a log
- ○ Check cholesterol regularly and keep a log

Q22 What effect will an infection most likely have on blood glucose?

○ Lowers it

○ Raises it

○ Has no effect

○ None of the above

Q23 Mr. Z is 62 years old with mild hypertension, high cholesterol, and a family history of stroke. He enrolls in a health club to lose weight and improve his fitness.

○ 75 minutes of mild activity 5 times a week

○ 150 minutes of mild activity 5 times a week

○ 75 minutes of moderate activity 5 times a week

○ 150 minutes of moderate activity 5 times a week

Q24 How would you explain aerobic exercise to a friend?

○ Lifting weights

○ Casual walk in the park

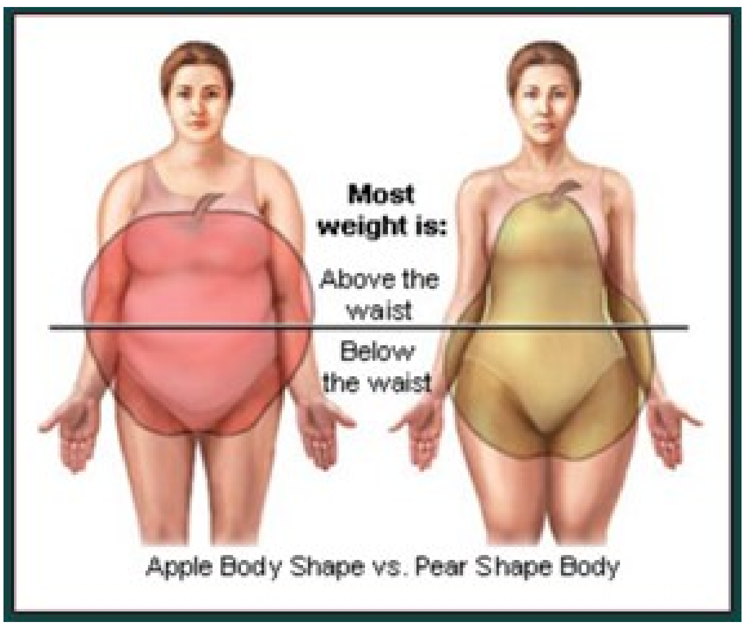
○ Brisk walk

○ Sitting for less period of time

Match the examples listed in column B with their definitions in column A. **Each response can be used only once.**

Column A	**Column B**		
	Jogging (1)	Fishing (2)	Mowing the lawn (3)
Q25 Moderate-intensity physical activity	○	○	○
Q26 Vigorous-intensity physical activity	○	○	○
Q27 Light-intensity physical activity	○	○	○

Q28 Directions: Look at the image below and answer question 28.



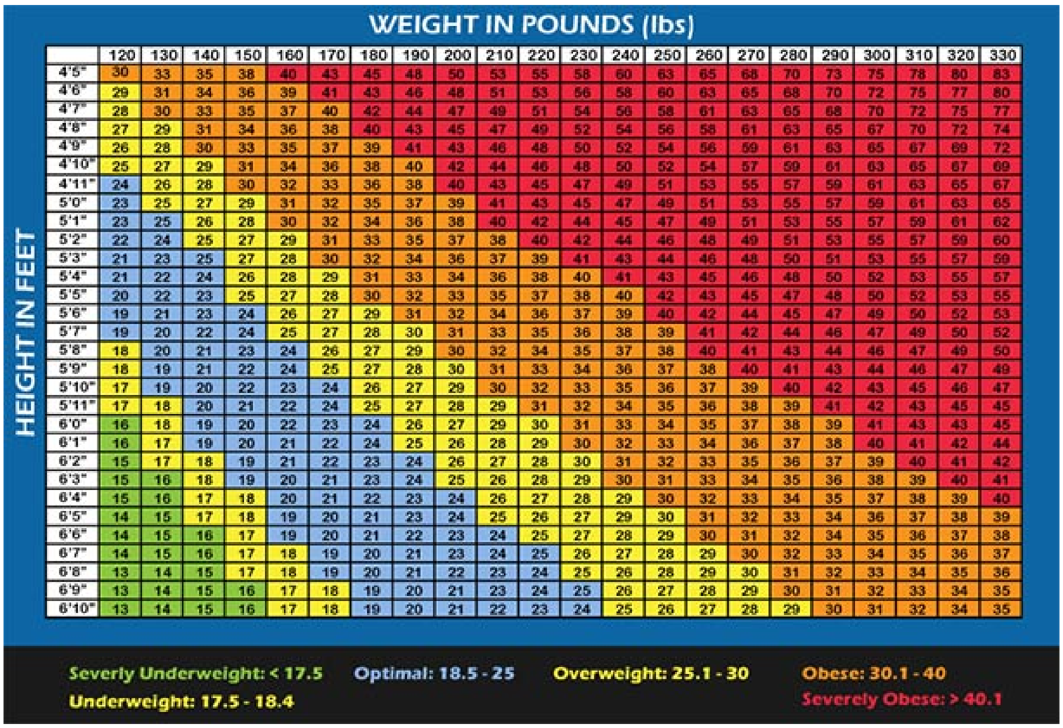
Apple Body Shape vs. Pear Shape Body

Q28 Identify the body shape that increases the risk of stroke and heart disease?

○ Apple shape

○ Pear shape

<u>Directions:</u> The body mass index (BMI) measures the weight in relation to the height. Using the chart below, answer questions 29 and 30.



	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330
4'5"	30	33	35	38	40	43	45	48	50	53	55	58	60	63	65	68	70	73	75	78	80	83
4'6"	29	31	34	36	39	41	43	46	48	51	53	56	58	60	63	65	68	70	72	75	77	80
4'7"	28	30	33	35	37	40	42	44	47	49	51	54	56	58	61	63	65	68	70	72	75	77
4'8"	27	29	31	34	36	38	40	43	45	47	49	52	54	56	58	61	63	65	67	70	72	74
4'9"	26	28	30	33	35	37	39	41	43	46	48	50	52	54	56	59	61	63	65	67	69	72
4'10"	25	27	29	31	34	36	38	40	42	44	46	48	50	52	54	57	59	61	63	65	67	69
4'11"	24	26	28	30	32	33	36	38	40	43	45	47	49	51	53	55	57	59	61	63	65	67
5'0"	23	25	27	29	31	32	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
5'1"	23	25	26	28	30	32	34	36	38	40	42	44	45	47	49	51	53	55	57	59	61	62
5'2"	22	24	25	27	29	31	33	35	37	38	40	42	44	46	48	49	51	53	55	57	59	60
5'3"	21	23	25	27	28	30	32	34	36	37	39	41	43	44	46	48	50	51	53	55	57	59
5'4"	21	22	24	26	28	29	31	33	34	36	38	40	41	43	45	46	48	50	52	53	55	57
5'5"	20	22	23	25	27	28	30	32	33	35	37	38	40	42	43	45	47	48	50	52	53	55
5'6"	19	21	23	24	26	27	29	31	32	34	36	37	39	40	42	44	45	47	49	50	52	53
5'7"	19	20	22	24	25	27	28	30	31	33	35	36	38	39	41	42	44	46	47	49	50	52
5'8"	18	20	21	23	24	26	27	29	30	32	34	35	37	38	40	41	43	44	46	47	49	50
5'9"	18	19	21	22	24	25	27	28	30	31	33	34	36	37	38	40	41	43	44	46	47	49
5'10"	17	19	20	22	23	24	26	27	29	30	32	33	35	36	37	39	40	42	43	45	46	47
5'11"	17	18	20	21	22	24	25	27	28	29	31	32	34	35	36	38	39	41	42	43	45	45
6'0"	16	18	19	20	22	23	24	26	27	29	30	31	33	34	35	37	38	39	41	43	43	45
6'1"	16	17	19	20	21	22	24	25	26	28	29	30	32	33	34	36	37	38	40	41	42	44
6'2"	15	17	18	19	21	22	23	24	26	27	28	30	31	32	33	35	36	37	39	40	41	42
6'3"	15	16	18	19	20	21	23	24	25	26	28	29	30	31	33	34	35	36	38	39	40	41
6'4"	15	16	17	18	20	21	22	23	24	26	27	28	29	30	32	33	34	35	37	38	39	40
6'5"	14	15	17	18	19	20	21	23	24	25	26	27	29	30	31	32	33	34	36	37	38	39
6'6"	14	15	16	17	19	20	21	22	23	24	25	27	28	29	30	31	32	34	35	36	37	38
6'7"	14	15	16	17	18	19	20	21	23	24	25	26	27	28	29	30	32	33	34	35	36	37
6'8"	13	14	15	17	18	19	20	21	22	23	24	25	26	28	29	30	31	32	33	34	35	36
6'9"	13	14	15	16	17	18	19	20	21	23	24	25	26	27	28	29	30	31	32	33	34	35
6'10"	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	35

Q29 If the height is 5 feet 7 (5'7") inches and the weight is 170lbs. What is the BMI?

○ 27

○ 26.5

○ 27.5

○ 25.5

Q30 From the BMI chart above, which weight group does this fall under?

- Underweight
- Overweight
- Obese
- Severely obese

Q31 Which of the following is the **strongest** risk factor for stroke?

- Abdominal obesity
- High Body Mass Index (BMI)
- Weight of 150 lbs.
- Skin fold thickness of 50-60mm

Q32 Which of the following is the best measure for obesity?

- Waist Circumference
- Waist-to-Hip Ratio
- Body Mass Index
- Body Fat Percentage

Q33 Ms. K, a 72-year-old woman is being discharged after a 1-week admission for a stroke. On discharge, she meets with a nutritionist who recommends following the DASH diet (Dietary Approaches to Stop Hypertension) to control high blood pressure. According to this diet plan, which of these should be consumed in **low** quantities?

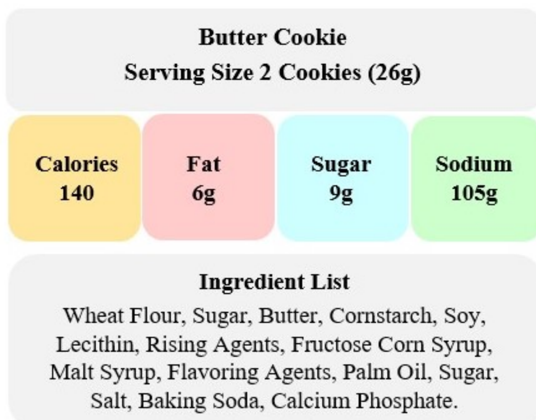
○ Potassium

○ Sodium

○ Protein

○ Vitamins

Directions: Look the nutrition facts label below and answer questions 34 and 35.



Q34 Looking at this nutrition label, identify the sources of sugar in the ingredient list:

○ Sugar, Butter, Palm Oil

○ Sugar, Lecithin, Fructose

○ Sugar, Fructose, Malt Syrup

○ Sugar, Baking Soda, Soy

Q35 Which of the following is the most important information to pay attention to on a nutrition label?

- ○ Total fat
- ○ Total carbohydrates
- ○ Sodium level
- ○ Serving size

Q36 Which of the following is highest in carbohydrates?

- ○ Baked chicken
- ○ Potato chips
- ○ Peanut butter
- ○ Baked potato

Q37 Which of the following is highest in fat?

- ○ Low fat (2%) milk
- ○ Orange juice
- ○ Corn
- ○ Honey

Q38 **Directions:** **Look at the MyPlate image below to answer question 38.**

Q38 This is a figure of MyPlate, the USDA's nutrition guide for healthy eating. It is depicted by a plate and glass divide into five food groups. Which are these?

- ○ 1- carbohydrates 2- protein 3- fats 4- vitamins 5- fiber
- ○ 1- fruits 2- grains 3- vegetables 4- protein 5- dairy
- ○ 1- carbohydrates 2- protein 3- minerals 4- vitamins 5- water
- ○ 1- protein 2- fruits 3- vegetables 4- grains 5- water

<u>Directions:</u> Look at the nutrition facts label for a packaged noodle soup to the right and answer question 39.

Nutrition Facts

6 servings per container

Serving size 1 1/2 cups (389g)

Amount per serving

Calories	**260**
	% Daily Value*
Total Fat 6g	**8%**
Saturated Fat 2.5g	**13%**
Trans Fat 0g	
Cholesterol 65mg	**22%**
Sodium 1110mg	**48%**
Total Carbohydrate 27g	**10%**
Dietary Fiber 7g	**25%**
Total Sugars 5g	
Includes 1g Added Sugars	**2%**
Protein 26g	
Vitamin D 0mcg	0%
Calcium 64mg	4%
Iron 3mg	15%
Potassium 940mg	20%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Q39 Which of the following determines the true sodium content of the can of soup?

- ○ Serving size
- ○ Calories
- ○ % Daily Value
- ○ Sodium in mg

Q40 Polyunsaturated fats help decrease the risk of stroke:

- ○ True
- ○ False

Match the terms listed in column B with their definitions in column A. **Each response can be used only once.**

Column A **Column B**

	Body Mass Index (BMI)	Saturated fats	Nutrients	Cholesterol	Calories	Waist-to-Height Ratio
Q41 A waxy kind of fat that travels in the body	○	○	○	○	○	○
Q42 Energy we get from food	○	○	○	○	○	○
Q43 Waist measurement divided by height measurement (W ÷ H)	○	○	○	○	○	○
Q44 Fats found in animal meat	○	○	○	○	○	○
Q45 A measure of weight adjusted for height (kg/m2)	○	○	○	○	○	○
Q46 Provide nourishment to the body	○	○	○	○	○	○

---------------- End of Test ------------